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ABSTRACT

This curriculum guide contains 5 teaching units for 44 agricultural business and management cluster problem areas. These problem areas have been selected as suggested areas of study to be included in a core curriculum for secondary students enrolled in an agricultural education program. The five units are as follows: (1) agribusiness operation and management; (2) animal science; (3) plant and soil science; (4) food science and technology; and (5) agricultural engineering/mechanization. Each problem area includes some or all of the following components: related problem areas, prerequisite problem areas, occupational tasks addressed, learning assessment plan sheets, instructor's guide, information sheets, student worksheets or assignment sheets and keys, demonstrations, transparency masters, and a discussion guide for transparencies. Suggestions are made for use of the core materials, including specific suggestions for using the different components of a problem area. Representative problem areas include marketing agricultural products and services; financing the agribusiness; understanding the animal production industry; classifying animals; enhancing soil fertility; preventing soil erosion and managing land; processing agricultural products; adhering to government regulations; welding and metalworking; designing, building, and maintaining agriculture services; and identifying career opportunities. (YLB)

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Agricultural Education Curriculum

Central Cluster
■ **Agricultural Business and Management Cluster**
Horticulture Cluster
Agricultural Resources Cluster

Illinois State Board of Education

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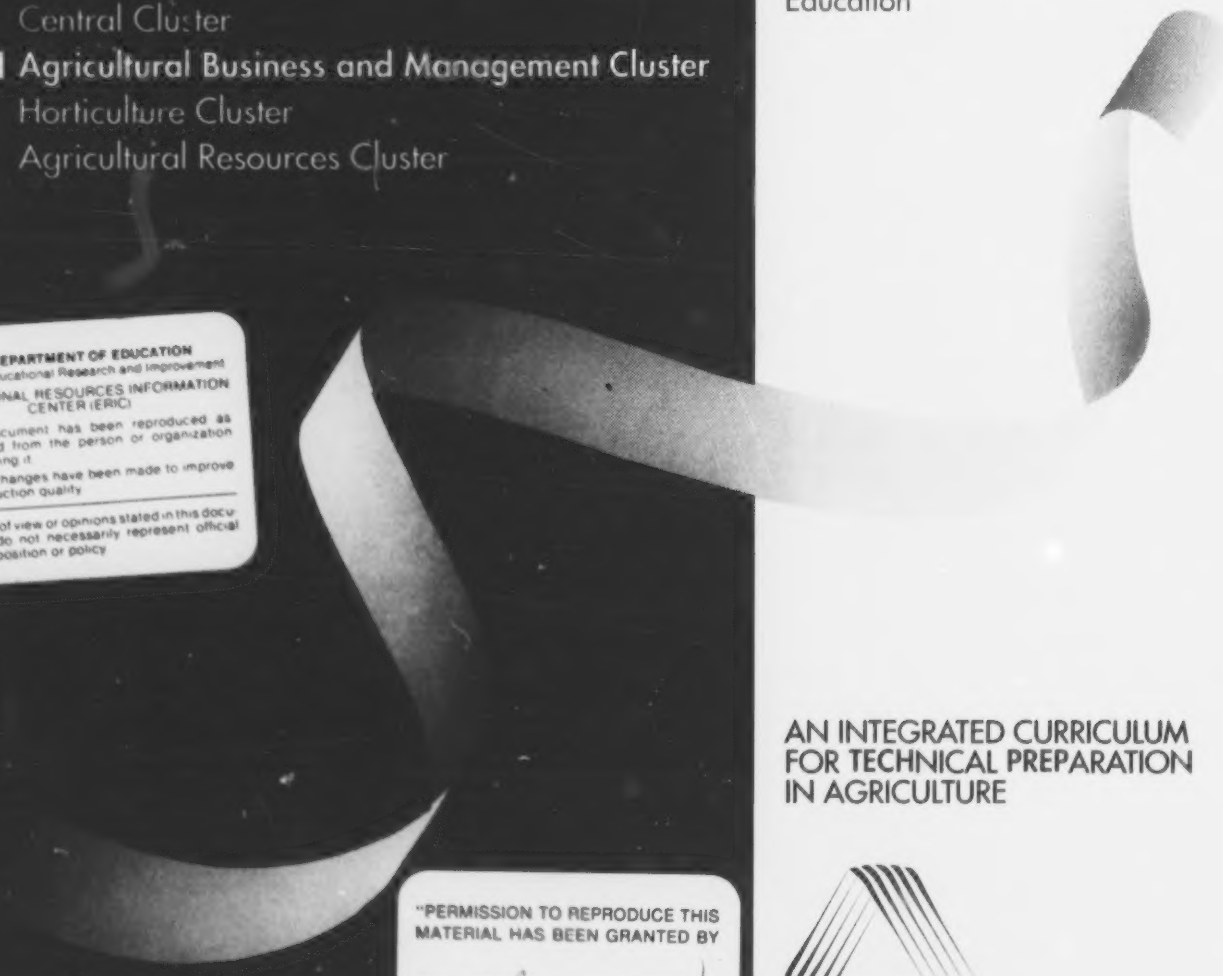

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AN INTEGRATED CURRICULUM FOR TECHNICAL PREPARATION IN AGRICULTURE

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Program Improvement Section

1989

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Acknowledgments

Appreciation is expressed to the many agricultural educators who shared their time, knowledge, and instructional aids for the preparation of this core curriculum. Without their cooperation and input, this printing would not have been possible.

Suggestions for Using Core Materials

It is recommended that teachers planning to use the attached curriculum guides and teaching aids refer to the **Illinois Plan for Agricultural Education: Secondary Core Curriculum Implementation Guide** for specific guidelines. This booklet includes ideas, suggestions and a step-by-step set of instructions for revising local programs and courses. These curriculum guides and teaching aids have been designed to improve instruction in agri-science and business management and to enhance student learning in these areas. Each problem area includes some or all of the following components:

1. Related problem areas
2. Prerequisite problem areas
3. Occupational tasks addressed
4. Learning assessment plan sheets
5. Instructor's guide
6. Information sheets
7. Student worksheets or assignment sheets and keys
8. Demonstrations
9. Transparencies
10. Discussion guide for transparencies

This curriculum guide should be utilized as a source unit. This means that teachers should selectively choose those components which they need to achieve their teaching objectives. The project staff does not recommend that teachers "teach" the core program as it is presented. Instead, the teacher should personalize and localize the materials for the particular group taught and, wherever possible, add other materials and teaching techniques to enrich the core program.

Teachers could teach everything included in the core curriculum but this would not be advisable considering the variations which exist in agriculture programs, students' needs and interests, and program objectives. Instead, teachers should select problem areas for a "local core" and supplement them with other problem areas important in the local area. Another suggestion is that an entire unit need not be taught to a given group during a given year. For example, teachers may want to teach part of the Food Science and Technology Unit to freshmen and teach the remaining part to an advanced class.

Specific suggestions for using the different components of a problem area are presented in the following section.

1. **Related problem areas.** These problem areas are included to assist teachers in planning their programs and course outlines. Teachers should review these problem areas when scheduling their courses to get an overview of the subject matter included in the core which is related to selected agricultural topics.
2. **Prerequisite problem areas.** Many of the core problem areas may require a current knowledge of science, mathematics, communications, or basic agricultural concepts. This section will alert the teacher if this problem area requires any previous or specific instruction.
3. **Occupational tasks addressed.** Instructors in Education for Employment programs have identified the occupational tasks which are to be taught in their courses. This section identifies those tasks from the state developed task lists which can be addressed within the context of this problem area.
4. **Learning assessment plan sheets.** The recently amended School Code of Illinois requires that goals for learning be identified and taught. This section identifies those State Goals for Learning and Learning Objectives which can be addressed within the context of this problem area.
5. **Instructor's guide.** The instructor's guide is not a lesson plan. It is a source of teaching ideas which may be implemented by the agriculture teacher to conduct an effective instructional program. Each guide includes more material than most teachers would use. Teachers should select from the several interest approaches and teaching activities those suggestions which seem most appropriate for the local situation. The instructor's guide emphasizes a problem-solving method and a student-centered, activity approach. Lecture-presentation and rote memorization of facts should be kept to a minimum. The instructor's guides include suggestions for carrying learning to the "doing" level. Application of classroom learning to SAEPs and FFA activities is an important part of the teaching process.
6. **Information sheets.** These sheets have been prepared for those problem areas where technical information on the subject may be difficult to locate. If reference materials are not available, the teacher may want to duplicate copies of the information sheets for class use.

7. **Student worksheets or assignment sheets and keys.** These exercises are designed as classroom activities for student use. They may provide a change of pace for students when introducing, reinforcing or mastering certain agricultural concepts. Most exercises include a teacher's key with suggested answers.
8. **Demonstrations.** The teaching of certain problem areas often calls for demonstrations of manipulative skills or scientific principles. The demonstration outline may be used by the teacher or students to conduct demonstrations of science principles and manipulative skills. Teachers may want to change some of the student activities included in the instructor's guide into student demonstrations.
9. **Transparencies.** Some of the problem areas include transparency masters which can be used to prepare transparencies for the teachers to use when discussing certain concepts and subject matter.
10. **Discussion guide for transparencies.** Most of the transparencies included in the core materials do not include on the overlay any narration or explanation. The discussion guide provides teachers with some suggested points to bring out in the discussion of a transparency including explanations, descriptions, and discussion questions related to the transparency. The information sheets may also provide pertinent information useful in the discussions associated with the transparencies.

The core materials, if used properly, can improve the teaching process and save valuable teacher time. At the same time, misuse or overuse of these materials may lead to a lock-step approach to teaching and learning with the teacher adding little in the way of resourceful innovations and creative techniques. **The Illinois Plan for Agricultural Education: A Planning Guide** stresses the need to broaden local curricula in order to meet the needs of several audiences. It emphasizes the need to address several objectives at each level of a comprehensive program. It is recommended that this booklet be reviewed as you are evaluating your local program needs.

For best results when using the Core Curriculum materials, teachers should:

1. Use the curriculum but don't handle it like a teaching plan.
2. Localize the curriculum for their community.
3. Personalize the curriculum for their students.
4. Supplement the curriculum to achieve local objectives.

Illinois State Board of Education

Department of Adult, Vocational and Technical Education
Program Improvement Section
Product Abstract

1. Title of material: Agricultural Business and Management Materials for Agricultural Education Programs
2. Date material was completed: June, 1989
3. Please check one: New material ____ Revised x
4. Originating agency: University of Illinois
   Address: Urbana, Illinois Zip Code: 61801
5. Name of developer: Dale A. Law
   Address: 1301 West Gregory, Urbana, IL Zip Code: 61801
6. Developed pursuant to Contract Number: OT-IO-688

---

7. Subject Matter (Check only one according to USOE Code):
   USOE Code
   - x 01 Agricultural Education
   - ____ 03 Business and Office Education
   - ____ 04 Distributive Education
   - ____ 07 Health Occupations Education
   - ____ 09 Home Economics Education
   - ____ 10 Industrial Art Education
   - ____ 16 Technical Education
   - ____ 17 Trade and Industrial Education
   - ____ Career Education
   - ____ Other (Specify)

---

8. Education Level:
   - ____ Pre-K Thru 6
   - ____ 7-8
   - x 9-10
   - x 11-12
   - x Post-Secondary
   - ____ Adult
   - ____ Teacher (Pre-service)
   - ____ Administrator (Pre-Service)
   - ____ Other (Specify) ____

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9. Intended for Use By:
   - x Student
   - x Classroom Teacher
   - ____ Local Administrator
   - ____ Teacher Educator
   - ____ Guidance Staff
   - ____ State Personnel
   - ____ Other (Specify) ____

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10. Student Type:
    - x Regular
    - x Disadvantaged
    - x Handicapped
    - ____ Limited English Proficiency
    - ____ Other (Specify) ____

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11. Medium and Format of Materials:
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      - ____ Minutes
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(217) 782-4620

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16. General Description:

This curriculum guide includes teaching units for the Agricultural Business and Management Cluster problem areas selected as suggested areas of study to be included in a core curriculum for secondary students enrolled in an agricultural education program.

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17. Person Completing this Abstract: Dale A. Law

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ILLINOIS AGRICULTURAL CORE CURRICULUM REVISION
UNITS AND PROBLEM AREAS

Agricultural Business & Management Cluster

Unit A: Agribusiness Operation and Management

1. Marketing Agricultural Products and Services
2. Financing the Agribusiness
3. Understanding Agricultural Law Applications
4. Insuring the Agribusiness
5. Planning and Organizing the Agribusiness
6. Advertising and Selling Agricultural Products and Services
7. Operating the Agribusiness
8. Managing Entrepreneurship Opportunities in Agriculture
9. Identifying Career Opportunities in Agribusiness Management
10. Using Microcomputers in Agribusiness Management

Unit B: Animal Science

1. Understanding the Animal Production Industry
2. Classifying Animals
3. Understanding Animal Anatomy and Physiology
4. Meeting Nutritional Needs of Animals
5. Understanding Animal Breeding and Reproduction
6. Maintaining Animal Health
7. Meeting the Enviornmental Requirements of Animals
8. Identifying Alternative Animal Production Systems: Aquaculture
9. Conserving Wildlife Resources
10. Caring for Animals
11. Identifying Career Opportunities in Animal Science
12. Understanding Economic Principles of Livestock Production

Unit C: Plant and Soil Science

1. Enhancing Soil Fertility
2. Preventing Soil Erosion and Managing Land
3. Classifying Soils
4. Classifying Plants
5. Propagating Plants
6. Understanding Plant Germination, Growth, and Development
7. Controlling Plant Pests
8. Maintaining Grain Quality
9. Identifying Career Opportunities in Plant and Soil Science
10. Identifying Alternative Crop Production Systems

Unit D: Food Science and Technology

1. Processing Agricultural Products
2. Adhering to Government Regulations
3. Meeting Nutritional Needs of Food Consumers
4. Packaging and Distributing Food Products
5. Identifying Career Opportunities in Food Science

Unit E: Agricultural Engineering/Mechanization

1. Welding and Metalworking
2. Designing, Building, and Maintaining Agriculture Services
3. Repairing and Maintaining Agricultural Equipment
4. Understanding and Maintaining Small Engines
5. Financing and Maintaining Agricultural Equipment
6. Manufacturing, Distributing, Selling, and Servicing Agricultural Equipment
7. Identifying Career Opportunities in Agricultural Engineering/Mechanization

UNIT A: Agribusiness Operation and Management

PROBLEM AREAS:

1. Marketing Agricultural Products and Services
2. Financing the Agribusiness
3. Understanding Agricultural Law Applications
4. Insuring the Agribusiness
5. Planning and Organizing the Agribusiness
6. Advertising and Selling Agricultural Products and Services
7. Operating the Agribusiness
8. Managing Entrepreneurship Opportunities in Agriculture
9. Identifying Career Opportunities in Agribusiness Management
10. Using Microcomputers in Agribusiness Management

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Marketing Agricultural Products and Services

RELATED PROBLEM AREAS:

1. Understanding the World Food and Fiber Chain (Central Core Cluster)
2. Applying Basic Economic Principles in Agribusiness (Central Core Cluster)
3. Advertising and Selling Agricultural Products and Services
4. Operating the Agribusiness
5. Processing Agricultural Products
6. Packaging and Distributing Food Products
7. Manufacturing, Distributing, Selling, and Servicing Agricultural Equipment
8. Marketing Horticultural Products and Services (Horticulture Cluster)
9. Advertising and Selling Horticultural Products (Horticulture Cluster)

PREREQUISITE PROBLEM AREA(S):

1. Understanding the World Food and Fiber Chain (Central Core Cluster)
2. Applying Basic Economic Principles in Agribusiness (Central Core Cluster)

LEVEL: Preparatory

OCCUPATIONAL TASKS ADDRESSED:

Agricultural Business and Management Cluster

Duty E: Performing Promotional Activities

1. Plan territory management
2. Analyze and interpret market information
3. Identify potential buyers

Duty H: Managing the Business

1. Evaluate agribusiness productivity
2. Use computer software for records and reports

STATE GOALS FOR LEARNING:

In planning the instruction for this problem area, teachers can promote the development of several student learning objectives which are related to the State Goals for Learning in Biological and Physical Sciences and Social Sciences. These objectives are listed on the Learning Assessment Plan forms included on the following page(s). Those learning objectives marked with an asterisk (*) are taken from the sample lists provided by the Illinois State Board of Education.

Illinois Agricultural Core Curriculum
Agricultural Education 124 Mumford Hall 1301 W. Gregory Drive University of Illinois Urbana, IL 61801

Directors: Dale A. Law, Ed.D.
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ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date ____________
☐ **Original submission** ☐ **Revision**
Page ____ of ____

I. LEARNING AREA *(check one)*
☐ Language Arts
☒ Mathematics
☐ Sciences
☐ Fine Arts
☐ Social Sciences
☐ Physical Development/Health

(Affix label or complete district information.)

COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐
District Name
City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to understand and use methods of data collection and analysis, including tables, charts and comparisons.

Contact Person: ____________
Title: ____________
Phone: (   )

III. LEARNING OBJECTIVES

By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:

III. LEARNING OBJECTIVES	IV. ASSESSMENT A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	V. EXPECTATIONS Percent of Students Expected to Achieve Objective
*1. Make reasonable references from graphical comparison of data sets.					
*2. Differentiate between a sample and a population.					
*3. Identify reasons for having a sample.					
*4. Distinguish from random sample and other kinds of samples.					
*5. Construct a circle graph with or without a computer.					
*6. Understand what type of graphical display best illustrates a given set of data.					
*7. Recognize how the median, mean, and range are affected by changes in extreme values.					
14					15

Submission Date ____________
☐ Original submission ☐ Revision
Page ____ of ____

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☐ Mathematics ☒ Social Sciences
☐ Sciences ☐ Physical Development/Health

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Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)

COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐

District Name

City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to apply the skills and knowledge gained in the social sciences to decision making in life situations.

Contact Person: ____________
Title: ____________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Compare the economic interdependence among agriculture, business, government, labor, and the consumer.					
*2. Recognize the economic interdependence between the United States economy and the world economy.					
3. Determine the derived demand associated with a marketing situation.					
4. Develop a sales forecast for a product or a service based upon internal and external factors.					
5. Utilize the analysis of strengths and weaknesses of competing firms to assist in the development of a marketing plan.					

Marketing Agricultural Products and Services

Illinois Agricultural Core Curriculum Rev.

Agricultural Business and Management
Agribusiness Operation and Management

ISBE 41-78 (1/86)

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
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LEARNING ASSESSMENT PLAN

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Submission Date ____________
☐ Original submission ☐ Revision
Page ____ of ____

I. LEARNING AREA *(check one)*
☐ Language Arts
☐ Mathematics
☐ Sciences
☐ Fine Arts
☒ Social Sciences
☐ Physical Development/Health

(Affix label or complete district information.)
COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐
District Name
City
Contact Person: ____________
Title: ____________
Phone: ( )

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to understand and analyze comparative political and economic systems with an emphasis on the political and economic systems of the United States.

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Describe the purposes and results of trade restrictions and trade promotions.					
*2. Compare the effects of a trade surplus, a trade deficit, a tariff, and an embargo on the economy of the United States.					
3. Identify the factors involved in a general economic forecast.					

ISBE 41-78 (1/88)

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Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date ____________
☐ Original submission ☐ Revision
Page ____ of ____

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☒ Sciences ☐ Physical Development/Health

(Affix label or complete district information.)
COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐
District Name
City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will have a working knowledge of the principles of scientific research and their applications in simple research projects.

Contact Person: ____________
Title: ____________
Phone: ( )

III. LEARNING OBJECTIVES	**IV. ASSESSMENT**				**V. EXPECTATIONS**
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Understand the need to acquire, organize, and evaluate data.					
*2. Demonstrate the ability to draw conclusions from collected data.					
3. Identify methods of collecting information for research.					
4. Identify the strengths and weaknesses of various methods of collecting information for research.					

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Marketing Agricultural Products and Services

STUDENT LEARNING OBJECTIVES

Upon completion of their study of this problem area, students will be able to:

1. Identify the major components of a marketing audit.
2. Apply a marketing audit in the analysis of a marketing situation.
3. Identify sources of information used to make a sales forecast.
4. Develop a sales forecast for an agribusiness product or service.
5. Identify the factors involved in determining a general economic forecast.
6. Construct a customer map for a market area.
7. Use a customer map to analyze an agribusiness firm's marketing area.
8. Identify strengths and weaknesses of competitive firms.
9. Develop marketing strategies that capitalize on the weaknesses of competitive firms.
10. Determine the derived demand associated with a marketing situation.
11. Identify the methods used for collecting customer information.
12. Identify the strengths and weaknesses of the different methods of collecting customer information.
13. Choose a method of collecting customer information for the analysis of a marketing situation.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Marketing Agricultural Products and Services

PROBLEMS AND QUESTIONS FOR STUDY

1. What are the major components of a marketing audit?
2. What is the purpose of a marketing audit?
3. Why is it important to have outsiders involved in marketing audits?
4. Why are sales forecasts particularly difficult to make in agribusiness firms?
5. Explain the differences between the following types of sales forecasts:
   a. Total market vs. market share.
   b. Short term vs. long term.
   c. Formal vs. informal.
6. What are some factors to consider when making a general economic forecast?
7. What is meant by derived demand?
8. What are some examples of derived demand for agribusiness products and services?
9. What marketing information can customer maps provide the agribusiness?
10. Give some reasons why customer maps often show customers clustered in particular areas?
11. How can an analysis of competitor strengths and weaknesses be used to develop a marketing strategy?
12. What methods are available for collecting information about customers?
13. What are the strengths and weaknesses of the different methods used to collect customer opinions and attitudes?
14. How is a focus group interview conducted?
15. Projects:
    a. Given a marketing situation, perform a marketing audit.
    b. Provided with the appropriate information, develop a sales forecast.
    c. Given information about the customers of an agribusiness, construct a customer map and analyze its implications for the market area.
    d. Provided with appropriate information, identify strengths, weaknesses, and strategies for competing within a market area.
    e. Given the types of customer information desired along with other pertinent information, choose a customer research strategy.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Marketing Agricultural Products and Services

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES

1. Conduct a class survey designed to collect information about students' product preferences. This could be an informal survey of one class, or it could be expanded to include other classes. Concentrate on one or two product lines such as garden seed, seed corn, tractors, pickup trucks, or herbicides. Once the data has been collected it can be used (1) to develop interest in this problem area for an introductory discussion, or (2) during the class when discussing market research.

2. Have the class design and conduct a market research project that pertains to FFA fruit or garden seed sales. A sales forecast could be made based upon the information collected.

3. Invite an agribusiness manager or market analyst to speak with the class and share examples of market forecasting and research.

4. Given a real or hypothetical agribusiness, have students design a survey to gather customer information in regard to products and services. Students can be divided into teams, each with different products and services, or given individual assignments. Once the survey questions have been written, arrange them in the form of a survey instrument. Pass the survey instrument out to the class for a discussion on its strengths and weaknesses. (Have them rewrite if time allows.)

5. Given a case study of an agribusiness competitor, have the students analyze its strengths and weaknesses and develop a marketing strategy that would capitalize upon its weaknesses.

6. Divide the class to represent two competing agribusinesses. Provide each group with market research data and have them develop a marketing forecast. Change the economic conditions and have them project the effects upon the agribusiness.

7. Given a marketing map of an agribusiness, have students evaluate it based upon its implications for marketing decisions.

8. Have a professional moderator conduct a short Focus Group Interview with the class. Immediately following the interview have the moderator share the information he or she collected and give examples of how Focus Group Interviews may be used by an agribusiness for collecting information.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Marketing Agricultural Products and Services

REFERENCES

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*4. *Agribusiness Management.* (1987). Downey, W.D., Erickson, Steven P. 2nd edition. McGraw-Hill Book Company, New York, NY.

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6. *Merchandising Agricultural Products.* (VAS Unit #U6027). Vocational Agricultural Service, College of Agriculture, University of Illinois, 1401 S. Maryland Drive, Urbana, IL 61801. (217) 333-3871.

7. *Agricultural Business Sales and Marketing.* (1984). Stewart, Bob R. University of Missouri - Columbia, Instructional Materials Laboratory.

*Indicates highly recommended reference

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTIONAL RESOURCES

These resources are intended for use by teachers in planning and teaching the materials for this problem area and may be adapted to fit the teaching method(s) used.

INFORMATION SHEET #1 — Terms to be Defined

INFORMATION SHEET #2 — Strength and Weakness Analysis

INFORMATION SHEET #3 — Market Mapping

INFORMATION SHEET #4 — Sample Cover Letter for Market Survey

INFORMATION SHEET #5 — Example Questionnaire for Fruit Sales

INFORMATION SHEET #6 — Example Questionnaire for Garden Seed Sales

INFORMATION SHEET #7 — General Farm Survey

TRANSPARENCY MASTER #1 — Survey Research Procedure

TRANSPARENCY MASTER #2 — Methods for Gathering Information for Marketing Research

TRANSPARENCY MASTER #3 — Internal Marketing Information

TRANSPARENCY MASTER #4 — Marketing Audit Steps

INFORMATION SHEET #1

Terms to be Defined

Competitive pricing — pricing methods based on competitors' prices, simply setting prices at the "going rate."

Decision making — the process of choosing a course of action between alternatives for the purpose of achieving desired results. A logical procedure for identifying the problem, discovering alternative solutions, analyzing them, and choosing a course of action. (Also known as Problem Solving)

Derived Demand — demand that is based on the demand for another product with which the product is closely associated or used in the production process. The demand for most farm supplies is derived from the demand for farm products.

Evaluation — the surveillance of progress to tell whether a plan is on course; it allows both the analysis of new information and the discovery of new opportunities.

Focus-Group Interview (FGI) — a guided discussion among users of a product or a service that is designed to discover consumer attitudes and opinions toward those products or services.

Forecast — an estimate of future business activity on which operating plans are based.

Market penetration — strength in a given market segment.

Market research — the study of customers, competition, and trends in the marketplace, all of which should provide objective, analytical information on which to base marketing decisions.

Market segmentation — the classification of customers into segments or categories according to applicable characteristics.

Marketing audit — an objective examination of a company's entire marketing program.

Marketing management — the management of the total process of identifying customer needs, developing products and services to meet these needs, establishing promotional programs and pricing policies, and implementing a system of distribution to customers.

Penetration pricing — a pricing strategy that consists of offering a product at a low price, perhaps even at a loss, in order to obtain a great deal of exposure and to gain wide acceptance quickly.

Planning — forward thinking about courses of action based upon full understanding of all factors involved and directed at specific objectives.

Strategic marketing plan — the logical integration of all business activities and resources to meet customers' needs and to generate a profit.

INFORMATION SHEET #2

Strength and Weakness Analysis

Competitor: Old Reliable Fertilizer and Chemical Company
By: New Crop Fertilizer and Chemical Company
Date: February 16, 1996

Weaknesses	Strengths
1. Store beginning to show age.	1. Older store with low overhead costs.
2. Equipment is in need of replacing and upgrading.	2. Good location.
3. On-farm calls are non-existent.	3. Sound financial backing.
4. Does not sell or service application equipment.	4. Management well established.
5. Carries a very low inventory of specialty products.	5. Major product lines are well accepted.

Strategies for competing against: Old Reliable Fertilizer and Chemical Company

1. Highlight our new facility and state-of-the art equipment through advertisements and open house.
2. Promote personal interaction on farm sales and customer service.
3. Expand sales and service of application equipment. Keep equipment on display and parts in inventory at the store.
4. Maintain moderate inventory levels of popular specialty items. Make arrangements with wholesaler for immediate supply when required

INFORMATION SHEET #3

Market Mapping

1. Pinpoint current customers.

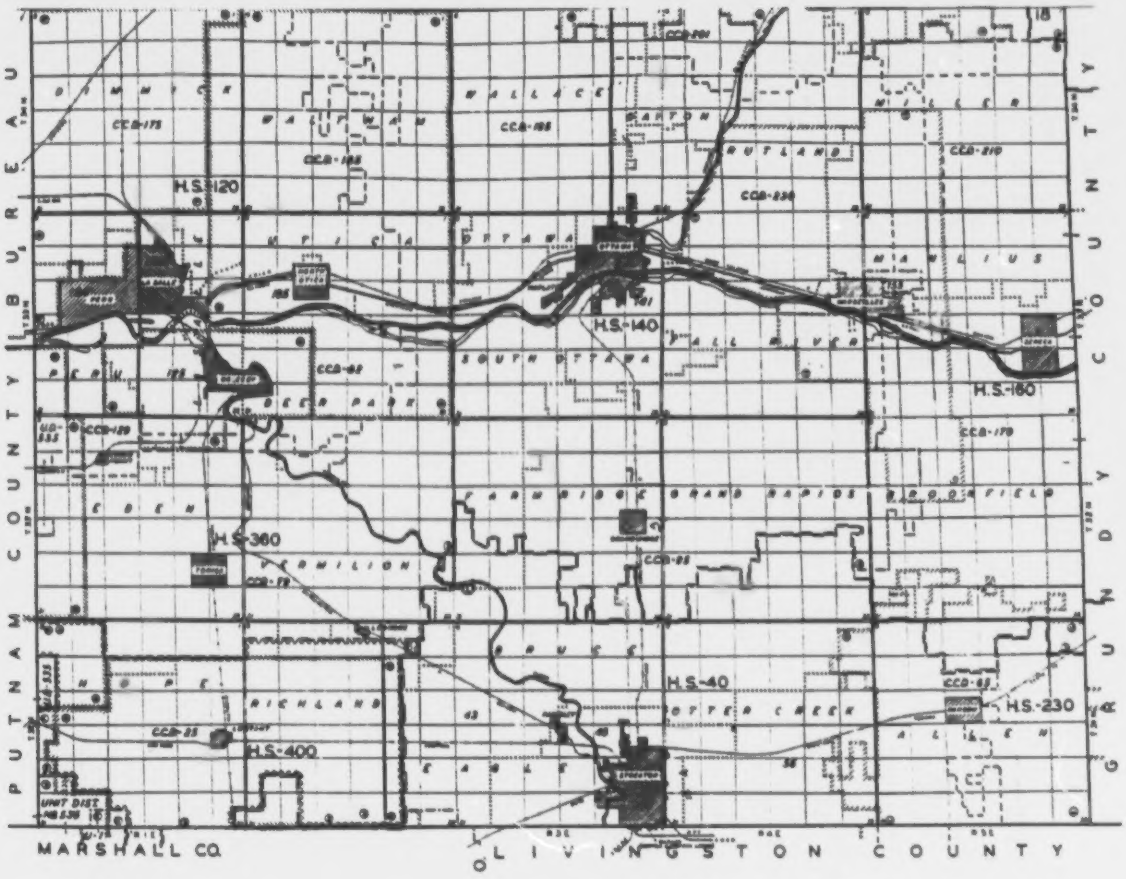
2. Pinpoint non-customers.

3. Code customers by business volume & products purchased.

4. Highlight Barriers:

   a. Geographical - rivers, major highways.
   b. Location of competition.
   c. Types of farms.

5. Target areas for increased sales promotion.


BUREAU COUNTY
PUTNAM COUNTY
MARSHALL CO.
LIVINGSTON COUNTY
GRUNDY COUNTY
KENDALL COUNTY
DIMMICK
WALTHAM
WALLACE
DAYTON
RUTLAND
MILLER
UTICA
OTTAWA
MANLIUS
FALL RIVER
SOUTH OTTAWA
PERU
DEER PARK
EDEN
FARM RIDGE
GRAND RAPIDS
BROOKFIELD
VERMILION
HOPE
RICHLAND
BRUCE
OTTER CREEK
ALLEN
EAGLE
H.S.-120
H.S.-140
H.S.-160
H.S.-360
H.S.-40
H.S.-230
H.S.-400
CCD-175
CCD-185
CCD-210
CCD-230
CCD-170
CCD-60
CCD-70
CCD-65
CCD-25
UNIT DIST NO. 535

INFORMATION SHEET #4

Sample Cover Letter for Market Survey

FFA Letterhead

Date

Dear __________ :

In an effort to increase the sale of garden seeds, provide additional services, and increase the number of customers we are asking for your help. If you would please take a few moments to complete the enclosed survey form and return it to us promptly we will do our best to serve you better. In class we are studying marketing and customer survey techniques. We decided to work on a real issue and developed this survey so that we can do a market analysis.

For taking the time to complete the survey and returning it to us promptly, we will be sending you a free gift.

Thank you for your help.

Sincerely,

INFORMATION SHEET #5

Example Questionnaire for Fruit Sales

1. Name of customer ______________________________

2. Address of customer ______________________________

3. Phone ______________

4. Have you purchased fruit from us before? ________ YES ________ NO

* If your answer to question number 4 was "NO" please go to question number 7. If your answer was "YES" please continue with question number 5.

5. How was the quality of the fruit? (Circle the appropriate number.)

Very Good	Good	Fair	Poor
1	2	3	4

6. How satisfied were you with the purchase? (Circle the appropriate number.)

Very Satisfied	Satisfied	Dissatisfied	Very Dissatisfied
1	2	3	4

7. During what month would you prefer to order fruit? ____________

8. During what month would you prefer to receive fruit? ____________

9. If it was necessary for you to pick the fruit up from a central location would you still purchase the fruit?
________ YES ________ NO

10. What is your preference, if any, of the State or company from which the fruit is obtained? ______________

11. If you had the opportunity to purchase fruit (other than grapefruit and oranges) that would be distributed at the same time, what would you choose? (check all that apply)
Apples ________ Pears ________
Peaches ________ Other (please indicate) ____________

12. What quantities of fruit do you prefer to purchase?
Oranges ________ Box(es)
Grapefruit ________ Box(es)

13. Given the opportunity to set your own price per box, what do you feel would be fair?
Oranges $ ________ /Box
Grapefruit $ ________ /Box

14. How much of the fruit that you purchase, if any, do you give away as a gift?
All ________ 3/4 ________
1/2 ________ 1/4 ________ none ________

15. If the fruit could be arranged and packaged in an appropriate fashion for a gift, would you be interested in this service? ________ YES ________ NO

16. Is there anything we can do to improve on our service of suppling fruit to you? Please list.

INFORMATION SHEET #6

Example Questionnaire for Garden Seed Sales

1. Name of customer ____

2. Address of customer ____

3. Phone ______________

4. Have you purchased garden seed from us before? ______ YES ______ NO

* If your answer to question 4 was "NO" please go to question number 7. If your answer was "YES" please continue with question 5.

5. How was the quality of the seed?
(Circle the appropriate number.)

Very Good	Good	Fair	Poor
1	2	3	4

6. How satisfied were you with the purchase?
(Circle the appropriate number.)

Very Satisfied	Satisfied	Dissatisfied	Very Dissatisfied
1	2	3	4

7. During what month would you prefer to order your garden seed? __________

8. During what month would you prefer to receive your garden seed? __________

9. What brand of seed do you prefer? __________

10. If you could purchase other items for your garden from us what would you be interested in? (examples: rain gauge, straw mulch, bagged fertilizer, garden tilling service, garden planting service) Check all that apply.

Vegetable Plants ______
Bagged Fertilizer ______
Outdoor Flowering Plants ______
Shade Trees ______
Fruit Trees ______
Rain Gauge ______
Straw Mulch ______
Garden Tilling Service ______
Garden Planting Service ______

11. On the average, how much money do you spend for garden seed each year? $ __________

12. What is the size of your garden? __________ sq. ft. or __________ acre(s)

13. Is there anything we can do to improve our service to you in supplying products and services to meet your gardening needs? Please list.

INFORMATION SHEET #7

General Farm Survey

1. Name of farm Operator ______________________________

2. Address of farm Operator ______________________________

3. Phone ______________

4. Name of Township at farm(s) location(s). ______________________________

5. Size of farm operation:

   a. tillable acres ________

   b. total acres ________

   c. head of livestock by species ________ ________ ________
   #/species #/species #/species

6. Types of equipment (Please name only one brand and the nearby business that you rely on for the sale and service of the equipment.):

		Brand Name	Business Name
	Example	Brand X	Brand X Agri Sales and Service
a.	tractors		
b.	field equipment		
c.	harvest equipment		
d.	grain handling and storage		
e.	feed handling and storage		
f.	livestock equipment		
g.	livestock buildings		

7. Crop and livestock inputs (Please name only the one nearby business that is your major source of supply for each input.):

		Business Name
a.	fertilizer source	
b.	herbicide source	
c.	seed	
d.	feed	
e.	fuel	

TRANSPARENCY MASTER #1

Survey Research Procedure

Define the Purpose of the Survey

Determine Population to be Surveyed

Develop, Test and Revise the Questionnaire

Collect Data

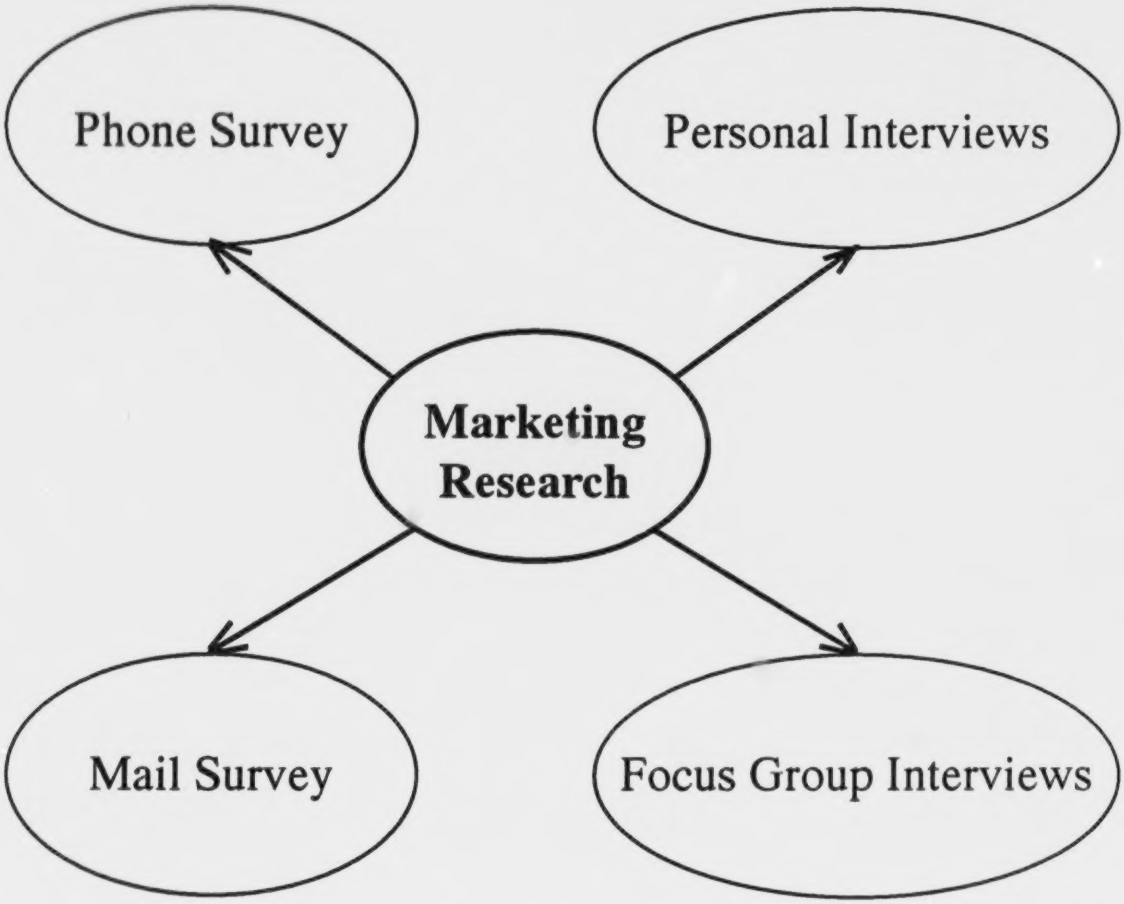
Analyze Data

Summarize Conclusions

Decide Action to be Taken

TRANSPARENCY MASTER #2

Methods of Gathering Information for Marketing Research



Marketing Research

Phone Survey

Personal Interviews

Mail Survey

Focus Group Interviews

TRANSPARENCY MASTER #3

Internal Marketing Information

1. Sales Records
2. Inventory Records
3. Purchase Orders
4. Customer Complaint Records
5. Advertising Records
6. Financial Statements

External Marketing Information

1. Census Data
2. Trade Association Information
3. Government Agency Reports
4. Professional Economic Analysis Reports
5. Reports from Periodicals and Newspapers
6. Voter Registration Lists

TRANSPARENCY MASTER #4

Marketing Audit Steps

A — **Analyze** the Market Success of Each Product

U — **Understand** the Relative Strengths of the Firm

D — **Determine** the Conditions in the Marketplace

I — **Identify** the Firm's Marketing Plan

T — **Take Notice** of the Effectiveness of the Implementation of the Marketing Plan

S — **Study** the Firm's Human Resources and Organizational Structure

STUDENT ACTIVITIES

STUDENT WORKSHEET #1 — Marketing Questions

For additional activities, teachers may refer to the "Suggested Teaching Activities and Procedures" section in the Instructor's Guide.

STUDENT WORKSHEET #1

Marketing Questions

1. Explain what a marketing audit is.

2. In what ways, if any, is a marketing audit similar to a financial audit?

3. What are the six major components of a marketing audit?

4. What types of information are needed to make a "sales forecast" for a specific business?

5. What types of information are needed to make a "general economic forcast"?

6. What types of information are needed to make a "market forecast" for a specific business?

7. What types of information are needed to make a sales forecast for a specific product or service?

8. Explain how a firm's competition can be effectively analyzed.

9. A customer map is one method of analyzing market penetration. What can be learned from a customer map that will assist in analyzing a market?

10. Complete the following frame on "methods of gathering data for research."

	Personal Interview	Phone Interview	Mail Survey	Focus Group Interview
1. **Cost** to Perform Scale: High Moderate Low				
2. **Speed** of Gathering Information Scale: High Moderate Low				
3. **Detail** or Depth of Information Gathered Scale: High Moderate Low				
4. **Ease** to Perform by the Researcher Scale: High Moderate Low				

11. What is meant by "derived demand"? Give an example of "derived demand."

12. In what ways has the significance of marketing research changed in the past decade?

13. What are the differences that might be found in marketing research for a large manufacturer of farm equipment, a large food processor, a neighborhood florist, and a farm management company?

14. Why is it important to have outsiders involved in evaluating a marketing plan?

15. What is the primary purpose of business? How does this purpose relate to marketing research?

16. Give an example of a typical marketing research question related to each of the following:

    a. Place —

    b. Product or Service —

    c. Price —

    d. Promotion —

17. Explain how you attempt to research any one of the research questions that you listed for the previous problem.

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Financing the Agribusiness

RELATED PROBLEM AREAS:

1. Marketing Agricultural Products and Services
2. Using Microcomputers in Agribusiness Management
3. Managing Entrepreneurship Opportunities in Agriculture
4. Keeping and Using Records in Agriculture (Central Core Cluster)
5. Applying Basic Economic Principles in Agribusiness (Central Core Cluster)
6. Applying Mathematics Skills in Agriculture (Central Core Cluster)

PREREQUISITE PROBLEM AREA(S):

1. Applying Mathematics Skills in Agriculture (Central Core Cluster)
2. Keeping and Using Records in Agriculture
3. Applying Basic Economic Principles in Agribusiness

LEVEL: Preparatory

OCCUPATIONAL TASKS ADDRESSED:

Agricultural Business and Management Cluster

Duty F: Financing the Agribusiness

1. Calculate operating expenses
2. Prepare cash flow projections
3. Prepare financial statements
4. Interpret financial statements
5. Prepare budget
6. Develop credit plan
7. Complete business loan application process
8. Prepare tax statement
9. Prepare depreciation schedule
10. Prepare cash flow statement

Duty H: Managing the Business

1. Use computerized software for records and reports

Horticulture Cluster

Duty Q: Managing the Business

1. Select computerized software for records and reports
2. Prepare periodic reports and financial statements using computer systems
3. Analyze financial statements using financial ratios

STATE GOALS FOR LEARNING

In planning the instruction for this problem area, teachers can promote the development of several student learning objectives which are related to the State Goals for Learning in Mathematics and Social Sciences. These objectives are listed on the Learning Assessment Plan forms included on the following page(s). Those learning objectives marked with an asterisk (*) are taken from the sample lists provided by the Illinois State Board of Education.

Illinois Agricultural Core Curriculum
Agricultural Education 124 Mumford Hall 1301 W. Gregory Drive University of Illinois Urbana, IL 61801

Director: Dale A. Law, Ed.D.
Principal Investigator: Jerry D. Pepple, Ed.D.
Research Assistant: James K. Shinn

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date ____________
☐ Original submission ☐ Revision
Page ____ of ____

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☐ Mathematics ☒ Social Sciences
☐ Sciences ☐ Physical Development/Health

(Affix label or complete district information.)

COUNTY	DISTRICT	ESC

District Name
City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to apply the skills and knowledge gained in the social sciences to decision making in life situations.

Contact Person: ____________
Title: ____________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Evaluate the costs and benefits of a particular course of action.					
*2. Compare the economic interdependence among agriculture, business, government, labor, and the consumer.					
*3. Understand the principles of money management including budgeting.					
*4. Apply the principles of money management to financial planning situations.					
5. Explain the preparation of a capital expense significance to financing an agribusiness.					
6. Discuss in detail the sources and uses of funds, and how an analysis of the sources and uses of funds can aid the financing of an agribusiness.					
7. List and explain the factors to be considered in the evaluation process used in decision making with regard to acquiring long-term assets.					
8. Explain in detail what concerns a lending institution will have when considering a loan for an agribusiness.					

ISBE 41-78 (1/86)

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date ____________________

☐ Original submission ☐ Revision

Page ____ of ____

I. LEARNING AREA *(check one)*

☐ Language Arts
☒ Mathematics
☐ Sciences
☐ Fine Arts
☐ Social Sciences
☐ Physical Development/Health

(Affix label or complete district information.)

COUNTY	DISTRICT	ESC

District Name

City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to perform the computations of addition, subtraction, multiplication, and division using whole numbers, integers, fractions, and decimals.

Contact Person: ____________________

Title: ____________________

Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Use computational and problem-solving skills in real life situations with or without a calculator as deemed appropriate.					
*2. Evaluate financial packages.					
*3. Understand government and other types of financial statements.					
4. Complete, explain, and discuss the importance of a balance sheet in financing an agribusiness.					
5. Complete, explain, and discuss the importance of a profit and loss statement in financing an agribusiness.					
6. Do a financial analysis of an agribusiness given the necessary data and formulas for financial ratios.					

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40

ISBE 41-78 (1/88)

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date ____________
☐ Original submission ☐ Revision
Page ____ of ____

I. LEARNING AREA *(check one)*
☐ Language Arts
☒ Mathematics
☐ Sciences
☐ Fine Arts
☐ Social Sciences
☐ Physical Development/Health

(Affix label or complete district information.)

COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐

District Name

City

Contact Person: ____________
Title: ____________
Phone: ( )

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to use mathematics skills to estimate, approximate, and predict outcomes and to judge reasonableness or results.

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Identify information that is relevant to a given situation.					
*2. Apply problem-solving procedures to solve or suggest a solution to a given problem.					
*3. Use mental arithmetic to estimate results of computations.					
4. Explain the preparation of a capital expense budget and its significance to financing an agribusiness.					
5. Discuss in detail how financial records are used and their significance to an agribusiness.					
6. List and explain the factors to be considered in the evaluation process used in decision making with regard to acquiring long-term assets.					
47					48

ISBE 41-78 (1/88)

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operations and Management

PROBLEM AREA: Financing the Agribusiness

STUDENT LEARNING OBJECTIVES

Upon completion of their study of this problem area, students will be able to:

1. Complete, explain, and discuss the importance of a balance sheet in financing an agribusiness.
2. Complete, explain, and discuss the importance of a profit and loss statement in financing an agribusiness.
3. Complete, explain, and discuss the importance of cash flow in financing an agribusiness.
4. Explain the preparation of a capital expense budget and its significance to financing an agribusiness
5. Explain the preparation of an accounts receivable record and its significance to financing an agribusiness.
6. Explain the need for and method of maintaining production control records and their significance to financing an agribusiness.
7. Explain how inventory records are kept, what purpose they serve, and how they assist in the financing of an agribusiness.
8. Discuss in detail how financial records are used and their significance to an agribusiness.
9. Do a financial analysis of an agribusiness given the necessary data and formulas for financial ratios.
10. Explain the significance of each financial ratio and how it is used in financial analysis.
11. Discuss in detail the sources and uses of funds, and how an analysis of the sources and uses of funds can aid the financing of an agribusiness.
12. Explain the budgeting process of cash.
13. Explain break-even analysis and demonstrate how changes in costs of production or selling price changes the break-even point.
14. Explain the concept of liquidity and how it relates to cash demands of the agribusiness.
15. List and explain the factors to be considered in the evaluation process used in decision making with regard to acquiring long-term assets.
16. Define the concept of equity and explain how it differs with the various types of agribusiness ownership.
17. Discuss in detail the various sources of cash to finance an agribusiness. List advantages and disadvantages of each.
18. Explain in detail what concerns a lending institution will have when considering a loan for an agribusiness.
19. Explain in detail what information an agribusiness manager needs to have prepared and what questions he or she needs to be prepared to answer, when applying for a loan for an agribusiness.
20. Describe the necessary business relationship between an agribusiness manager and the lending institution(s) which serves the agribusiness.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operations and Management

PROBLEM AREA: Financing the Agribusiness

PROBLEMS AND QUESTIONS FOR STUDY

1. Why do agribusinesses keep financial records?
2. What two financial documents are prepared to make up what is call the business financial statement?
3. What kinds of financial information would you expect to find in a financial statement?
4. In addition to the financial statement many other financial documents are prepared. Can you suggest what kinds of information or types of documents might be prepared?
5. Why is it important for an agribusiness to prepare budgets?
6. What steps would you feel are necessary to follow in preparing a budget?
7. Why is a balance sheet called a snapshot of the agribusiness?
8. Why is a profit and loss statement called a motion picture of the agribusiness?
9. What important financial concerns are made clear through the preparation of a cash flow statement?
10. What is the relationship between accounts receivable and the financial well-being of an agribusiness?
11. Why is it important for an agribusiness to keep accurate records of production and inventory?
12. What is meant by the term financial analysis and how is financial analysis used in an agribusiness?
13. What factors should be considered when determining the break-even point of an agribusiness operation?
14. What are assets?
15. How are assets acquired?
16. How does the agribusiness plan for the acquisition of assets?
17. What financial concerns do the owners and investors have in an agribusiness?
18. What effects does the seasonal nature of agriculture have on the total financial picture of any agribusiness?
19. What information would you expect a lending institution to require about an agribusiness before lending money to the agribusiness?
20. Where could you go to get money to finance an agribusiness?
21. As an agribusiness manager, what would you look for in a lending institution that you expect to work with for an extended period of time?

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operations and Management

PROBLEM AREA: Financing the Agribusiness

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES

1. Begin the problem area by setting up a fictitious situation where each student in your class has been working for ten years in an agribusiness. One day the owner comes to the student and announces plans to retire at the end of the year. The owner likes how the student has been working, and does not want to see the business disappear. The owner offers the student the opportunity to buy the agribusiness. It is a well-established business, has room for improvement, is a real good opportunity for the student, but the student is going to have to borrow some money in order to buy the business. The questions are: Is the business as successful as it appears on the surface? How can the student find out? How does the student go about getting the necessary money?

2. Make a list, on the chalk board or a transparency, of all the things students feel they need to find out.

3. Once the list is complete, ask students how they would go about acquiring and organizing the information.

4. Based upon the list developed as a result of question #3, guide the students through a discussion of basic financial records, documents, budgets, methods of analysis, and lender's concerns. An introduction of terminology and discussion of meanings should be quite helpful at this time.

5. Once terms and general meanings have been discussed students should each prepare the complete set of financial documents listed below:

   a. a balance sheet
   b. a profit and loss statement
   c. a cash flow
   d. a capital expense budget
   e. an accounts receivable record
   f. a production control record
   g. an inventory record
   h. the nine important operating ratios as a financial analysis of the agribusiness and a meaningful interpretation of each
   i. a break-even analysis
   j. a loan application

6. Once prepared, the students' work should be checked for accuracy and a discussion held in class on the usefulness of each financial document to the new owner, the lender, and the investors in the agribusiness.

7. Given a set of hypothetical records, ask students if they feel the agribusiness is in good financial condition or not. Have students prepare a paper giving their responses and reasons why they feel as they do. If this business is not in good financial condition suggest at least two ways in which the business could improve. Students must also be prepared to defend their responses in class.

8. It is also recommended that all of the following people visit the class, perhaps as a panel, to discuss their roles in the total financial picture of an agribusiness:

   a. a bookkeeper
   b. an accountant
   c. a comptroller
   d. a manager/owner
   e. a banker or other lending institution officer

INSTRUCTOR'S NOTES AND REFERENCES

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INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operations and Management

PROBLEM AREA: Financing the Agribusiness

REFERENCES

INSTRUCTOR'S NOTES AND REFERENCES

*1. *Illinois Agricultural Software Service Guide (Private Sector).* (Bulletin #AE-4646). (1989). Erickson, D.E., Greene, J.C. Agricultural Economics Department, University of Illinois, Urbana, IL 61801.

*2. *Agribusiness Finance.* (1981). DeVino, Gary T. Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

*3. *Agribusiness Management.* (1987). Downey, W. D., Erickson, S.P. McGraw-Hill Publishing Company, 1221 Avenue of the Americas, New York, NY 10020.

*4. *Business Plan.* (1987). Turok, Norma. Cooperative Extension Service, College of Agriculture, University of Illinois, Urbana, IL 61801.

*Indicates highly recommended reference

INSTRUCTIONAL RESOURCES

These resources are intended for use by teachers in planning and teaching the materials for this problem area and may be adapted to fit the teaching method(s) used.

INFORMATION SHEET #1 — Terms to be Defined

INFORMATION SHEET #2 — Financial Records

INFORMATION SHEET #3 — Functions of Financial Records

INFORMATION SHEET #4 — The Balance Sheet

INFORMATION SHEET #5 — The Profit and Loss Statement

INFORMATION SHEET #6 — Cash Flow Statement

INFORMATION SHEET #7 — Capital Expense Budget

INFORMATION SHEET #8 — Accounts Receivable Record

INFORMATION SHEET #9 — Production Control

INFORMATION SHEET #10 — Inventory Records

INFORMATION SHEET #11 — Analysis of Financial Records

INFORMATION SHEET #12 — Examples of Financial Analysis

INFORMATION SHEET #13 — Break-Even Analysis

INFORMATION SHEET #14 — Cash Management

INFORMATION SHEET #15 — Evaluating Acquiring Long-Term Assets

INFORMATION SHEET #16 — Equity and its Uses

INFORMATION SHEET #17 — Sources of Financing

INFORMATION SHEET #18 — What the Lender Wants to Know

TRANSPARENCY MASTER #1 — Balance Sheet for Sunrise Fertilizers, Inc.

TRANSPARENCY MASTER #2 — Profit and Loss Statement for Sunrise Fertilizers, Inc.

TRANSPARENCY MASTER #3 — Cash Flow Statement for Sunrise Fertilizers, Inc.

TRANSPARENCY MASTER #4 — Capital Expense Budget

TRANSPARENCY MASTER #5 — Additional Sales to Offset Loss

TRANSPARENCY MASTER #6 — Accounts Receivable Record

TRANSPARENCY MASTER #7 — Mixing Ticket

TRANSPARENCY MASTER #8 — Inventory Record

TRANSPARENCY MASTER #9 — Inventory for Sunrise Chemical and Fertilizer

TRANSPARENCY MASTER #10 — Break-Even Graph

TRANSPARENCY MASTER #11 — Variation in Cash Requirements for an Agribusiness

TRANSPARENCY MASTER #12 — Overlay for Transparency Master #11

TRANSPARENCY MASTER #13 — Overlay for Transparency Master #11

INFORMATION SHEET #1

Terms to be Defined

Accounts payable — monies owed to outside businesses for purchases made on credit which are expected to be paid in one year or less.

Accounts receivable — as a result of granting credit to customers, this money is owed to the business for purchases made by the customers.

Balance sheet — an accounting statement that shows a balance between assets and claims against those assets. The statement is for a specific time showing what the business owns and owes, and what owners have invested in the company.

Break-Even point — the point at which income from sales exactly equals the costs resulting from the generation of those sales.

Budget — a written plan of how the resources of the business are to be used during a particular period. It can serve many purposes but generally is used to check performance and operation.

Capital — generally all the assets of the business. It can include assets that are owned or borrowed monies.

Liabilities — what a business owes to other businesses or individuals outside of the business.

Net worth — (owners equity) what owners have invested in the business recorded in dollars. It is the total of assets of the business minus the total liabilities.

Profit and loss statement — an accounting statement that indicates what has occurred over a period of time, and that will show the profit and loss of the business for that time period. The profit and loss is determined by a comparison of income and expenses.

Cash flow statement — a projection of the income, expenses, and cash needs for the business. While maintaining a minimum cash balance, it allows the business to anticipate its operating cash needs. They are generally prepared quarterly or annually and are broken down into monthly cash needs.

Capital expense budget — a plan to prepare for the replacement of capital items.

Inventory — items stored for sale or to be used in the production of a product or supplying of services.

Turnover — the number of times something is used in the business during a particular time period. For example, inventory turnover shows the number of times inventory is used and replaced within a year.

Bond — a form issued by a business which identifies a specific amount of money to be repaid on a specific date as a result of a loan.

Common stock — a share in the ownership of a corporation which may require the corporation to pay a share of the corporate profits to the stockholder and allows the stockholder a vote on some corporate issues.

Preferred stock — a share in the ownership of a corporation which guarantees a share in the profits and redemption privileges but no voting rights.

Debenture — a promise to pay a loan but which may require security against assets, stock, or property of the business.

Promissory note — a promise to pay a specific amount of money and a specific amount of interest to a lender by a specific date.

Margin — the difference between the cost to produce a product or provide a service, and the selling price.

Profit — what remains after the costs have been subtracted from income of the business.

INFORMATION SHEET #2

Financial Records

The financial records listed below are considered to be the most important for most agribusinesses. This list may vary depending upon the type and size of the agribusiness.

1. Balance Sheet (see Information Sheet #4 and Transparency Master #1).
2. Profit and Loss Statement (see Information Sheet #5 and Transparency Master #2).
3. Cash Flow (see Information Sheet #6 and Transparency Master #3).
4. Capital Expense Budget (see Information Sheet #7 and Transparency Master #4).
5. Accounts Receivable Record (see Information Sheet #8 and Transparency Master #6).
6. Production Control (see Information Sheet #9).
7. Inventory Records (see Information Sheet #10 and Transparency Masters #8 and #9).

INFORMATION SHEET #3

Functions of Financial Records

1. For Management — The base from which management makes plans and decisions for the future are the financial records of the past performance of the agribusiness.

2. For Taxes — Every agribusiness is required by law to report taxable income to the Internal Revenue Service. Cooperatives which distribute patronage refunds in various forms must also be prepared to report such activity to the I.R.S. Accurate records of financial activities must be retained for reporting to the I.R.S.

3. For Credit Purposes — Agribusinesses today can not operate without borrowed capital. Lenders require that borrowers demonstrate through financial records their ability to manage well and repay debts in a timely manner. Periodic inspection of financial records to monitor the agribusiness's financial status may also be required once a loan has been made.

4. For Owners — Those individuals that have funds invested in an agribusiness should be informed on a regular basis about the financial condition of the agribusiness in relation to their investments in the agribusiness.

INFORMATION SHEET #4

The Balance Sheet

The balance sheet is a snapshot of the financial position of the agribusiness at a particular moment in time. In other words, the balance sheet says "this is where we were financially when this document was prepared."

The balance sheet is made up of three separate parts:

1. *Assets* are the total dollar values of every resource used by the agribusiness in order to do business. *Assets* are further separated into three categories:
    a. Current assets — cash and other items that could be converted to cash within one year.
    b. Fixed assets — capital items which can be used to generate cash but which generally remain for extended periods of time, e.g., land, buildings, machinery, and equipment used to manufacture, process, or provide services.
    c. Other assets — monies held aside for future use in investment or insurance.

2. *Liabilities* equal the total amount of money the agribusiness owes to banks, individuals, or any other business. *Liabilities* are separated into two categories:
    a. Current liabilities — the total dollar value of all debts that must be paid within one year.
    b. Long-term liabilities — the total dollar value of all debts which will fall due after one year. Mortgages and other long-term loans are most common. An important fact to keep in mind is that the portion of long-term liabilities, such as monthly payments, which fall due within a year are moved to current liability status.

3. *Net Worth* or *Owners Equity* is the balancing portion of the balance sheet. It is the difference between what the agribusiness owns and what it owes. Subtract the total liabilities from the total assets and the remainder is referred to as *net worth* or *owners equity*. This amount is what individuals or groups have invested in the business and the retained earnings of the business.

To check the accuracy of the balance sheet, add the total liabilities and net worth together and they should equal the total assets. (Refer to Transparency Master #1.)

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INFORMATION SHEET #5

The Profit and Loss Statement

This statement may be referred to under several titles: Profit and Loss, P and L, Earning Statement, Income Statement, or Income and Expense Statement. The Profit and Loss Statement is often compared to a motion picture of how the agribusiness got from one balance sheet to the next balance sheet. The profit and loss statement can also be broken down into three categories:

1. Income — which consists of all sales generated during the time period of the profit and loss statement minus the cost of goods that were sold. What is left, the remainder, is referred to as the gross margin. Depending upon the type of agribusiness, other income may have been generated as well. This income is also reported and makes up part of the gross margin. The total gross margin is what will be used to pay expenses, and if there is any money left this will be considered as profit or savings.

2. Expenses — which consist of the dollar value paid out during the time period of the profit and loss statement to generate sales. This dollar amount would include such things as payroll and the cost of items needed to manufacture a product or to market it. Depreciation, which is the dollar value of a fixed asset lost due to the use of the fixed asset, is also recorded as an expense. The total expenses are then subtracted from the gross margin to get net operating profit or margin. At this point, some additional income such as interest on savings or returns on investments may be added, and additional expenses such as owed interest from loans may be subtracted. Once these are figured, the final category of net profits is the result.

3. Net Profit or Net Earnings — which is the figure that remains at the bottom of the profit and loss statements. It indicates what the agribusiness has left to invest or return to owners.

Refer to Transparency Master #2.

INFORMATION SHEET #6

Cash Flow Statement

Agribusinesses, because of the seasonal nature of agriculture, often have wide fluctuations in the flow of cash in and out of the agribusinesses. A cash flow statement properly prepared will allow management to be prepared for the fluctuations and make the necessary adjustments to plan for the cash needs of the agribusiness.

The anticipated flow of cash in and out of the agribusiness is generally recorded on a spread sheet divided into twelve columns representing each month of the year. As the figures for each month are entered the cash needs of the agribusiness for the month and/or months ahead are indicated. Each column is also divided into rows which represent anticipated amounts of income, expenses, monies to be borrowed, monies to be paid back, and monies carried over to the next month.

Refer to Transparency Master #3.

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INFORMATION SHEET #7

Capital Expense Budget

As an agribusiness continues to operate, the capital items used in its operation tend to wear out and require replacement. As technology makes advances the agribusiness may need to replace capital items with newer items to remain efficient and competitive. If an agribusiness is to expand to increase production or move into a new market area, then a demand for additional capital items results. A capital expense budget is simply a tool which management can use to plan for acquiring capital items. The capital expense budget generally includes the specific item, when it will be purchased, and where the funds will come from to acquire the capital item.

Refer to Transparency Master #4.

INFORMATION SHEET #8

Accounts Receivable Record

An essential part of doing business is the extension of credit to customers. This extension of credit is especially true of agribusiness because of the seasonal nature of agriculture and because, in many cases, the purchase price may be very high.

The extension of credit is like investing money in capital items in that there are costs associated with it. When customers purchase products or services using credit rather than cash money, this results in the agribusiness not having that money available for other uses. Should the customers fail to pay off their credit loans, this failure can be a very expensive loss to the agribusiness.

Money owed by customers for credit extended is recorded by the agribusiness as accounts receivable and the monitoring of these accounts is called aging accounts receivable. When aging accounts receivable, the agribusiness is looking at how many days its accounts receivable are outstanding and what percent of the total accounts receivable fall into each pre-established range of days.

It is an unfortunate fact of life in business that the longer an account goes unpaid the less likely it is that it will ever be paid. If economic conditions in rural areas decline, it will usually be reflected in the number of accounts that become past due. The agribusiness must monitor the percentage of accounts at each level and as the percentage changes toward longer time periods, greater efforts must be applied towards collection.

The chart below demonstrates the amount of additional sales that must be generated at various profit levels to recover various amounts of uncollectible accounts. It is important to keep in mind however, that the agribusiness really never offsets the loss, because if it were able to generate additional sales it means the sales were always there and could have been generated without the debt loss.

Profit Margin

	5%	10%	20%
$ in Uncollectable Accounts	New Sales Generated to Offset Loss		
$1,000	$20,000	$10,000	$5,000
$5,000	$100,000	$50,000	$25,000
$20,000	$400,000	$200,000	$100,000

Refer to Transparency Masters #5 and #6.

INFORMATION SHEET #9

Production Control

Any agribusiness that used ingredients in the process of producing a product such as fertilizer or chemicals, must keep accurate records of quantities used and the cost. It is also important to keep accurate records because costs do not generally stay constant for extended periods of time, and failure to keep these records of cost changes and resulting adjustments in selling prices can dramatically affect earnings.

Two separate documents can be used in combination to keep accurate records. The documents will vary from one type of agribusiness to another but they should contain the following:

1. Mixing ticket system which permits identification of the amount of product used.

2. A summary cost report of the total number of units of ingredients used to produce a particular product along with the costs.

Refer to Transparency Master #7.

INFORMATION SHEET #10

Inventory Records

Inventory is anything the agribusiness owns that it plans to sell directly or will use as an ingredient in making a product or providing a service. A separate inventory would also consider everything the agribusiness owns that is not intended for sale.

No matter how careful an agribusiness is in keeping an accurate count of its inventory some of it will disappear. Using the most sophisticated computer monitoring systems still requires a physical count of all inventory periodically. The best system can not protect against shrinkage, spoilage, poor estimation, inaccurate measurements, and theft.

One of the most common and simplest ways to keep track of inventory is to maintain a running inventory or first-in first-out method. This method keeps a running account of the product, how much was there to start, plus amount of additional purchases, minus the dollar amount of sales at cost. This will result in the ending inventory. This is a very simple and effective method. However, with today's computer systems many more details can be monitored just as easily

Refer to Transparency Master #8.

INFORMATION SHEET #11

Analysis of Financial Records

The financial statement of an agribusiness which consists of the balance sheet and profit and loss statement can be used to do a careful analysis of the agribusiness. Using ratios as a method of analysis and the financial statement as the source of financial data, an agribusiness can identify its strengths and weaknesses and the direction it is headed. The information gained from an analysis aids management in determining the direction the agribusiness needs to follow for success.

Caution is advised when doing financial analysis using ratios. Ratios are only indicators of a situation, they do not necessarily mean a particular situation exists, but indicate where problems may exist and should be explored in more detail. A ratio is a comparison of two items of a similar nature. In financial analysis it is the dividing of the value of one account by the value of a second account. The ratio may be expressed in three ways: as a fraction (3/5), as a percentage (60%), or as a ratio (3:5).

A financial analysis may be done within an agribusiness firm comparing a particular set of data to a previous set of data for the same firm. Financial analysis can also be done by comparing a particular agribusiness's records to those of another similar agribusiness, using records compiled by a related trade association. **CAUTION** is advised here because there are so many differences among the records of the individual agribusinesses that make up the industry as a whole.

The following ratios have been developed from year-end operating statements and balance sheets. Agribusinesses having adequate records will find comparison of these ratios most revealing and helpful. There are nine various financial ratios. These are:

1. **Current Ratio (Liquidity)** — figure by dividing Current Assets by Current Liabilities. This ratio compares the total of cash and the items which will be converted into cash, with debts which must be paid soon. Thus the ratio reflects the ability to handle current debts. A ratio of 2.00 to 1 ($2.00 of Current Assets for each $1.00 of Current Liabilities) is considered satisfactory. When the ratio falls below 2.00 to 1, creditors have a greater interest in Current Assets than the owner.

2. **Ownership Equity** — figure by dividing Net Worth by Total Assets. Ownership Equity is shown on the "Net Worth" line of the balance sheet. This ratio shows how much of the business is proprietor-owned; and conversely, by subtracting the percentage from 100 percent, it shows how much of the business is financed by outside capital (creditors).

3. **Receivables Turnover** — figure by dividing the total Sales by Accounts Receivable. The turnover rate is meaningful when customer receivables are related to the corresponding customer sales. This ratio shows whether or not receivables are in proportion to amount of business transacted and might be used every month to good advantage. Divide sales year-to-date by receivables and compare with ratio for same period in past two or three years. Unfavorable trends can thus be detected.

4. **Net Working Capital Turnover** — figure by subtracting Current Liabilities from Current Assets. Rate of turnover is figured by dividing Sales by Net Working Capital. How many times Net Working Capital turns over in a year in Sales is a good measure of activity for any business. It is a sensitive indicator of overtrading or undertrading, and as such, it is a good test of the adequacy of Net Working Capital for the scale of operations of the firm. When this ratio is too high, it will usually be found that the business is short of cash and heavy on receivables and paid-for inventory. This situation promotes borrowing or sale of equipment at a loss to meet payroll and other fixed obligations. When it is too low, inefficient use of capital in the business is indicated. It is usually attended by a pile-up of receivables or inventory or cash, or a combination of these, in excess of the needs of the business.

5. **Turnover of Total Assets** — figure by dividing Sales by Total Assets. The importance of this ratio is illustrated in the question of why a business with $750,000 of Total Assets achieves Total Sales of $1,500,000 while another with an equal amount of assets achieves a Total Sales volume of only $1,000,000. The first would seem to be more efficient in its use of assets. However, a high rate of turnover is not necessarily the key to profits. As in the ratio, Sales to Net Working Capital, high turnover may be an indicator of inadequate capital in relation to sales volume.

6. **Return on Assets** — figure by dividing Net Profit by Total Assets. This ratio, too, is an important test of operating efficiency. It is a test of the quality of management in the utilization of the assets of the business. It lays aside all problems related to the source of funds, whether such funds are obtained from capital investment, borrowing, or purchases on credit. It shows the return on total capital invested in the business (owner capital plus outside capital), which is represented by Total Assets.

7. **Return on Net Worth** — figure by dividing Net Profit by Net Worth. In using this ratio, it is important that a fair salary for the owner be included in operating expenses of the business. The owner's time is certainly worth something; therefore, all Net Profit ratios should be based upon the profit *after* this salary is paid or taken into consideration in the figuring. Adequacy of profit must be measured in the light of current returns on money in the investment market, as well as compensation for risk.

8. **Inventory Turnover** — figure by dividing Cost of Sales by Inventory. Cost of Sales may be figured, if needed, by subtracting Margin from the corresponding Sales. This ratio shows the number of times inventory is bought and sold during the year, reflected in "turnover" in the balance sheet studies.

9. **Solvency** — figure by dividing the Total Liabilities by the Net Worth. This figure will tell if creditors or owners are supplying funds used by the business and is one of several measures of solvency. Creditors want to see a low figure here because it means more funds are supplied by owners which indicates loans are more secure. The owners view a high creditor input as being very good because it allows for expansion. A ratio of 1 indicates the owner is providing 50 percent of the capital and 50 percent of the capital is borrowed.

Adapted from Equipment Dealers Cost of Doing Business, 1987. National Farm and Power Equipment Dealers Association, 10877 Watson Road, St. Louis, MO 63127

INFORMATION SHEET #12

Examples of Financial Analysis

Liquidity or Current Ratio

$$\frac{\text{Current Assets}}{\text{Current Liabilities}} = \frac{\$185{,}000}{\$162{,}500} = 1.14:1$$

Ownership Equity

$$\frac{\text{Net Worth}}{\text{Total Assets}} = \frac{\$24{,}000}{\$330{,}000} = 0.27:1$$

Receivables Turnover

$$\frac{\text{Sales}}{\text{Accounts Receivables}} = \frac{\$500{,}000}{\$50{,}000} = 10:1$$

Net Working Capital Turnover

NWC = Current Assets - Current Liabilities
NWC = $185,000 - $162,500
NWC = $22,500

$$\frac{\text{Sales}}{\text{NWC}} = \frac{\$500{,}000}{\$22{,}000} = 22.72:1$$

Turnover on Total Assets

$$\frac{\text{Sales}}{\text{Total Assets}} = \frac{\$500{,}000}{\$330{,}000} = 1.5:1$$

Return on Assets

$$\frac{\text{Net Profit}}{\text{Total Assets}} = \frac{\$40{,}000}{\$330{,}000} = 0.12:1 \text{ or } 12\%$$

Return on Net Worth

$$\frac{\text{Net Profit}}{\text{Net Worth}} = \frac{\$40{,}000}{\$74{,}000} = 0.54:1 \text{ or } 54\%$$

Inventory Turnover

Cost of Sales = Sales - Margins = $500,000 - $250,000 = $250,000

$$\frac{\text{Cost of Sales}}{\text{Inventory}} = \frac{\$250{,}000}{\$80{,}000} = 3.125:1$$

INFORMATION SHEET #13

Break-Even Analysis

Another analysis which helps determine the overall financial needs of the agribusiness is the break-even analysis. To do a break-even analysis, the agribusiness must first determine the following:

1. Fixed costs — are costs which remain constant over a given period regardless of the amount of business conducted such as taxes, salaries, and rent.

2. Variable costs — are costs incurred as a result of sales. There is a direct relationship between the volume of business done during a given period and the cost incurred such as cost of goods sold, labor, fuel, or energy.

3. Semi-variable costs — are costs which remain constant up to a certain level of sales and then change. These should be averaged out for the given period and separated into fixed and variable costs.

By using data from the profit and loss statement and separating it into fixed and variable costs, a graphic representation can be developed to illustrate the break-even point. Anything below the break-even point results in a loss and anything above the break-even point results in a profit.

Refer to Transparency Master #10. As can be seen on the graph, a change in units sold or sales dollars can indicate a profit or loss. One common use of such a graph is to see what a change in the selling price per unit of product will do to profits. **CAUTION!** Just as with many analysis tools the break-even analysis may not give a true picture under every circumstance. For example:

1. If an increase in sales volume is needed it may mean a decrease in the selling price per unit. This may mean a change in variable costs.

2. If a change in sales volume of one item within the business occurs it may mean changes in the sales volume of related items.

3. Updates in cost and price should be carried out frequently to assure accurate depiction of the situation.

In break-even analysis the assumption is that things are as they appear on the graph and will remain constant. This is generally not the case. Break-even analysis is however, a good management tool when consideration is given to the factors which can come to bear on the figures.

INFORMATION SHEET #14

Cash Management

Liquidity is the ability to pay short-term debt, usually the ability to pay bills which fall due within one year. An agribusiness must remain liquid or be able to pay current liabilities with current assets. This money is called working capital. The agribusiness must also have some assets (usually cash) left for anticipated expenditures for plant and/or equipment.

An agribusiness having problems with liquidity usually has several problems which can include:

1. Passing up discounts for cash purchases from suppliers.
2. Making late payments to suppliers.
3. Need to monitor cash situation almost daily.
4. Need to get to bank to cover checks written the same day.

Cash needs to be managed like every other area of an agribusiness. There are two primary concerns of management regarding cash:

1. How much cash should be kept available at all times?
2. How should additional funds be added to the cash account and/or should the additional funds be invested in interest-bearing ventures?

Because of the seasonality of agriculture, cash requirements vary considerably over a year's time. The variations in cash requirements may mean borrowing of large sums during peak seasons which then must be paid off during slack seasons along with the interest. The alternative is to have large sums of cash available all the time so peak season demands are met; but then slack seasons mean an excess of capital that is not working for the agribusiness.

It should be apparent that some method of determining whether to borrow or save cash is needed. To do this, look at the current interest rate charged to borrow money and figure the total amount this would be for the year. Compare this to the current interest being paid on invested capital in accounts with easy access. By subtracting interest earned from interest paid it can be determined which is more profitable for the agribusiness.

There are many options available today with regard to both borrowing and investing capital. A careful analysis of costs versus benefits, high return versus no risk, and safety versus low return should be done, keeping in mind the needs of the agribusiness and its owners.

The inflow of cash (checks) should be handled promptly to assure maximum use of funds and interest. The outflow should be left until the due date for the same reasons unless discounts for early payment are given. If discounts are available they must be evaluated to determine how they fit into cash requirements.

INFORMATION SHEET #15

Evaluating Acquiring Long-Term Debt

To acquire long-term assets (buildings, equipment, machinery, and other items expected to last more than one year) requires careful consideration of all possible alternatives. Remember that commitment to the purchase of long-term assets becomes a long-term line item in the expenses of business. Evaluation requires a study of:

1. Alternatives to be examined — size, energy requirements, labor requirements, labor displacement, environmental impact, different sources, service, life expectancy, disposal or trade-in of old units, down time, training for use, compatibility with other units, etc.
2. Financial considerations — cash outlay versus returns, cost savings in the future, costs to get unit operational, freight and setup costs, salvage value of old unit, increased inventory, increased accounts receivable, investment credit such as reduction in taxes, etc.
3. Cash flow benefits — the long-term asset value and its associated costs may be "plugged into" the Profit and Loss Statement to see what impact it will have on the after-tax profits of the agribusiness.
4. Time value of money — can be determined in many ways. It is suggested that the references which are listed earlier in this problem area be examined if a more detailed study of the present value of money or Net Profit value is desired. Internal rate of return or weighted cost of capital charts are also included in the starred references which can give many of these figures.

It is important to remember that many alternatives exist for the use of capital to acquire long-term assets. Careful evaluation is necessary to maximize profits from any purchase.

INFORMATION SHEET #16

Equity and its Uses

Equity in privately owned agribusiness corporations is generally identified as being one or more of three types: common stock, preferred stock, and/or retained earnings. In a privately owned agribusiness, capital is supplied by the owner or owners as part of their personal business. Major agribusiness corporations will have publicly owned and traded stocks available through the major stock exchanges.

In each case the advice of a banker or investment banker becomes necessary in order that the greatest amount of capital can be realized at a minimum of expense. When the issuance of stock is recommended the smaller the corporation, the more difficult it becomes to attract buyers. The buyers of common stock have voting rights and in a closely held private corporation most stock is owned by a very few individuals. Although someone may wish to invest in a private corporation, it would be very difficult to have much impact on issues through voting based on the number of shares owned because the majority of shares will be owned by a small group, usually family members. Investment in a small, closely held private corporation is considered a high risk venture but if risk capital is available such investments have been quite profitable at times. Caution is advised, but remember, most major agribusinesses started as closely held private corporations.

Federal regulations and state laws have very specific guidelines which must be followed when issuing corporate stock. Use of a corporate attorney is recommended.

Corporations which make a profit may choose to issue a stock dividend or retain profits as retained earnings to improve the financial strength of the business.

Farmer-owned cooperatives are designed so that the major portion of financial needs are supplied by member patrons through direct investment or through dollars generated as a result of doing business. Direct investment is the direct purchase of stock in the cooperative. Depending on the cooperative's needs and management, stock may be issued as common voting stock, common nonvoting stock, or preferred stock which carries a specific dividend.

A profitable cooperative may choose to issue cash rebates of all profits to its member patrons or pay income tax on the profits and keep the balance as retained earnings for future use. Most cooperatives do a combination of cash rebates, stock or certificate issuance, and retained earnings.

Equity capital for any agribusiness is important to the successful operation of the business, as this is one of the key areas a lending institution will examine in deciding to lend money.

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INFORMATION SHEET #17

Sources of Financing

In order to select a source for financing, the agribusiness must first determine its needs and then it can determine which source of financing can best meet those needs. Some sources of financing are:

1. Banks — businesses whose primary purpose is to make a profit. Keeping the profit motive in mind, it should be easy to understand why banks tend to be more conservative and at the same time have higher rates of interest.

   Most banks are used as a source of funds for short-term seasonal demands for capital. Banks do not generally loan money to businesses for long-term capital investments. Other types of lending institutions can usually give better rates for long-term capital investments than banks. Banks will require that a business has not only a specific plan prepared in advance showing the use of funds but also a repayment plan. Often with agribusinesses money borrowed from banks is for supplies or inventory to meet approaching peak season demand. The bank will expect repayment shortly after the peak season is over.

   It is very important for agribusinesses to have a good working relationship with one or two local banks. The more familiar the bank is with a particular agribusiness and its seasonal needs the better prepared the bank can be to serve the agribusiness. If an agribusiness conducts business (loans, checking accounts, savings accounts) with one or two local banks on a regular basis this can influence interest rates charged for loans to the agribusiness and the ease with which a loan can be made, e.g., by a telephone request.

2. The Bank for Cooperatives — bank that has members which are farmer-owned cooperatives, in the same way that farmer-owned cooperatives have individual farmers as members. There is a network of these banks across the nation that traditionally lend money to farmer-owned cooperatives for both short-term and long-term (15 years) needs at or near the lowest rates available.

   Funds available for lending are generated by the sale of bonds by the bank for cooperatives. The interest rate on loans to farmer-owned cooperatives is based on the interest rates paid on the sale of bonds.

   There are very specific guidelines which the banks for cooperatives must follow in making loans. These guidelines change from time to time and must be examined by a farmer-owned cooperative and the banks for cooperatives before loans can be made.

3. Farmers Home Administration — an agency of the Federal Government which is set up to guarantee loans made by banks for businesses outside of metropolitan areas of 50,000 or more people. Their philosophy statements stress three goals:

   a. Developing or financing business or industry.
   b. Increasing employment.
   c. Controlling or abating pollution.

   The FmHA will guarantee 90 percent of the principle and interest loss incurred by a lending institution because of default of a borrower.

   Long- and short-term loans can be guaranteed. Loans on land and buildings are limited to 30 years, loans on machinery and equipment are limited to 15 years, and loans on working capital are limited to 7 years.

4. Small Business Administration — an agency of the Federal Government which will guarantee loans made through local banks not to exceed $750,000. The majority of these loan guarantees are for long-term only, with the minimum at 6 years and the maximum at 25 years. Borrowers must have exhausted all other possible sources of funds before being considered by the SBA.

   Both the SBA and the FmHA have the authority to make loans directly. However, no federal funds have been available for several years. It is therefore the responsibility of the borrower in both cases to negotiate the best possible terms with a local bank and then get federal loan guarantees.

Many other sources of financing are available to agribusinesses. Some of the more commonly used sources are: Bonds, debentures, promissory notes, and personal loans from friends or relatives. Each of these has its advantages and disadvantages and should be explored carefully before using it as a source of financing.

Another alternative which an agribusiness might consider is not to own but rather to lease a piece of equipment. If a particular item is apt to change frequently due to changes in technology, or its use by the agribusiness is for very short periods of time, a lease may be advisable. Leasing is attractive when interest rates on loans are close to fees for leasing, but often leasing is more expensive. Like all sources of financing, leasing has its advantages and disadvantages which must be considered carefully before agreements are made.

From a borrower's point of view, there are several facts to consider when selecting a lending institution. These include:

1. What is the asset to equity ratio required by the lender? The more conservative the lender, the higher the ratio (30 to 40 percent), whereas guaranteed loan plans may be looking for 10 percent.

2. What are the lending limits of the lending agency?

3. Does the lending institution understand agribusiness?

4. What are the types and numbers of services available from the lending institution? Federal Loan Plans do not offer the full services of a bank, which may force the agribusiness to work with several institutions. This may not be bad, but does make it more difficult to establish records for future transactions.

5. What are the costs of borrowing funds? Besides the current interest rate, there are less obvious costs to borrowing money.

    a. The Farmers Home Administration and the Small Business Administration both have service fees based on a percentage of the loan. These fees increase the cost of borrowing money.
    b. Stock purchase requirements by the bank for cooperatives based on a percentage of the loan can raise costs.
    c. A requirement by a lending institution to maintain a minimum balance in a low or no-interest account is expensive when the money could be working for the agribusiness.
    d. When an agribusiness borrows from an institution which in turn borrows from a bank, all costs of both institutions are passed on to the borrower, resulting in increased costs of the loan.

Many options are available to agribusiness when shopping for the best source for a loan. Careful examination of each and considering all the facts will result in the least costly terms.

INFORMATION SHEET #18

What the Lender Wants to Know

Once the decision has been made to borrow money for use in the agribusiness, the question then becomes, What do I need to prepare for the lender?

Any lender is going to want to see the agribusiness's balance sheet and profit and loss statement to determine current financial conditions. In addition to these financial statements, the agribusiness should be prepared to answer the following questions:

1. How much money does the agribusiness need to borrow?
2. What is the purpose of the loan, seasonal or long-term or perhaps both?
3. Seasonal borrowing generally requires repayment within the year. Can the agribusiness demonstrate through a cash flow its ability to repay the loan in this manner?
4. Long-term loans are generally for assets of large capital items. What are these?
5. Can a long-term loan be repaid by the profits generated from the purchase of a fixed asset or capital item?
6. After the loan is made how will this influence the agribusiness debt to net worth ratio? In other words, if the debt to net worth ratio is acceptable before the loan will it remain so after the loan?

An existing agribusiness can usually answer most of these questions using its records of performance, but in the case of a new business that is just starting, realistic projections become the only way to satisfy the lender. Newly formed agribusinesses will also need to provide information about management, particularly education and experience.

Depending upon the size of the loan and the length of the repayment schedule many more documents may be asked for by the lender. Possible documents include:

1. Source and use of funds statement and analysis.
2. List of loan securities.
3. Accounts receivable schedule.
4. Debt schedule.
5. Performance summaries by department for larger agribusinesses.
6. Budgets and forecasts for cash, sales, profit, accounts receivable, operating expenses, and cash flow.

Of concern to management because of its effects on the freedom to manage finances once a loan is made are:

1. The length of the loan.
2. The interest rates.
3. The repayment schedule.
4. Collateral requirements.
5. Restriction of borrowing at a future date before present loans are paid off.

Before borrowing be sure all terms of the loan are understood. Such terms as repayment requirements, collateral requirements and restrictions, and interest will all affect decisions made for the future of the agribusiness. It is recommended that the instructor visit a local lending institution and acquire copies of loan applications for students to examine. A loan officer may help by visiting the class and explaining forms.

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TRANSPARENCY MASTER #1

Balance Sheet for Sunrise Fertilizers, Inc.

Assets		
Current assets:		
Cash	$25,000	
Accounts receivable	$50,000	
Inventory	$80,000	
Prepaid expenses	$20,000	
Other	$10,000	
Total current assets		$185,000
Fixed assets:		
Land	$15,000	
Buildings	$50,000	
Less: Accumulated depreciation	$20,000	
	$45,000	
Equipment	$150,000	
Less: Accumulated depreciation	$75,000	
	$75,000	
Total fixed assets	$120,000	
Other assets	$25,000	
Total assets		$330,000

Balance Sheet (Con't.)

Liabilities		
Current liabilities:		
Accounts payable	$83,000	
Notes payable	$75,000	
Taxes payable	$3,000	
Wages payable	$1,500	
Total current liabilities		$162,500
Long-term liabilities:		
Mortgages	$78,500	
Other	$15,000	
Total long-term liabilities		$93,500
Total liabilities		$256,000
Net Worth		
Owner-invested capital:		
Common stock	$50,000	
Retained earnings	$24,000	
Total net worth		$74,000
Total liabilities and net worth		$330,000

TRANSPARENCY MASTER #2

Profit and Loss Statement for Sunrise Fertilizer's Inc.

Sales	500,000	
Cost of goods sold	250,000	
Gross margin		250,000
Operating expenses		
Salary and wages, including benefits	85,000	
Local taxes, licenses	5,000	
Insurance	6,000	
Depreciation	20,000	
Rent and lease	7,000	
Advertising and promotion	5,000	
Office expense	2,000	
Utilities	3,000	
Maintenance and repair	17,000	
Bad-debt loss	2,000	
Supplies	4,000	
Other	4,000	
Total operating expense		160,000
Net operating profit	90,000	
Interest expense	15,000	
Other nonoperating income	5,000	
Net profit before taxes		80,000
Profit taxes		40,000
Net profit after taxes		$40,000

TRANSPARENCY MASTER #3

Cash Flow Statement for Sunrise Fertilizers, Inc.

	1	2	3	4	5	6	7	8	9	10	11	12
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Bal Brought Fwd.	2000	1973	50302	25024	89859	69583	69419	62669	60119	60629	57839	51382
Cash receipts:												
Cash sales	4589	36891	39586	78026	8789	9365	10896	8789	8789	8789	8789	8789
Accounts receivable	6895	25613	25698	4646	4646	4646	4646	4646	5896	4646	4646	4646
Other income	25	54	54	54	54	54	54	54	54	54	54	54
Total cash receipts	11509	62558	65338	82726	13489	14065	15596	13489	14739	13489	13489	13489
Cash payments:												
Raw materials	5685	6464	56987	6464	26000	6464	6464	6464	6464	6464	6464	6464
Payroll	5689	5689	5689	5689	5689	5689	5689	5689	5689	5689	5689	5689
Loans & other expenses	52	548	548	548	548	548	1589	2358	548	2598	548	548
Advertising	25	458	458	458	458	458	2589	458	458	458	5986	5987
Selling expense	25	69	69	2598	69	69	2569	69	69	69	258	69
Administrative expense	35	878	878	878	878	878	878	878	878	878	878	878
New plant and equipment	25	123	25987	1256	123	123	2568	123	123	123	123	123
Other payments	0	0	0	0	0	0	0	0	0	0	0	0
Total cash payments	11536	14229	90616	17891	33765	14229	22346	16039	14229	16279	19946	19758
New short-term loans												
Monthly payment	0	0	0	0	0	0	0	0	0	0	0	0
New long-term loans												
Monthly payment	0	0	0	0	0	0	0	0	0	0	0	0
Cash balance	1973	50302	25024	89859	69583	69419	62669	60119	60629	57839	51382	45113

TRANSPARENCY MASTER #4

Capital Expense Budget

Capital Item	Purchase Date	Sources of Funds
Office Addition	19--	Earnings and Borrowed Capital
Delivery Van	19--	Earnings
Electronic Processor	19--	Earnings
Storage Facility	19--	Borrowed Capital
Greenhouse Addition	19--	Borrowed Capital
Customer Applicator	19--	Earnings
Automated System	19--	Borrowed Capital
Delivery Van	19--	Earnings

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TRANSPARENCY MASTER #5

Additional Sales to Offset Loss

	Profit Margin		
	5%	10%	20%
$ in Uncollectable Accounts	New Sales Generated to Offset Loss		
$1,000	$20,000	$10,000	$5,000
$5,000	$100,000	$50,000	$25,000
$20,000	$400,000	$200,000	$100,000

TRANSPARENCY MASTER #6

Accounts Receivable Record
(an aging schedule)

Days Outstanding	Percentage of Accounts Receivable
0 — 30	60
31 — 45	20
46 — 60	15
60 +	5

TRANSPARENCY MASTER #7

Mixing Ticket

Product ____________________ Date _______

Inputs used	Units (lbs, tons, gallons)
____________	________________________
____________	________________________
____________	________________________
Total	________________________

Summary Cost Report

Product _______________ Dates: from ___ to __

Inputs used	Units (lbs, tons,gals)	$/unit	Cost
____________	_________	_____	_____
____________	_________	_____	_____
____________	_________	_____	_____

Total Cost _____

Cost per Unit _____

TRANSPARENCY MASTER #8

Inventory Record

Ending Date ________

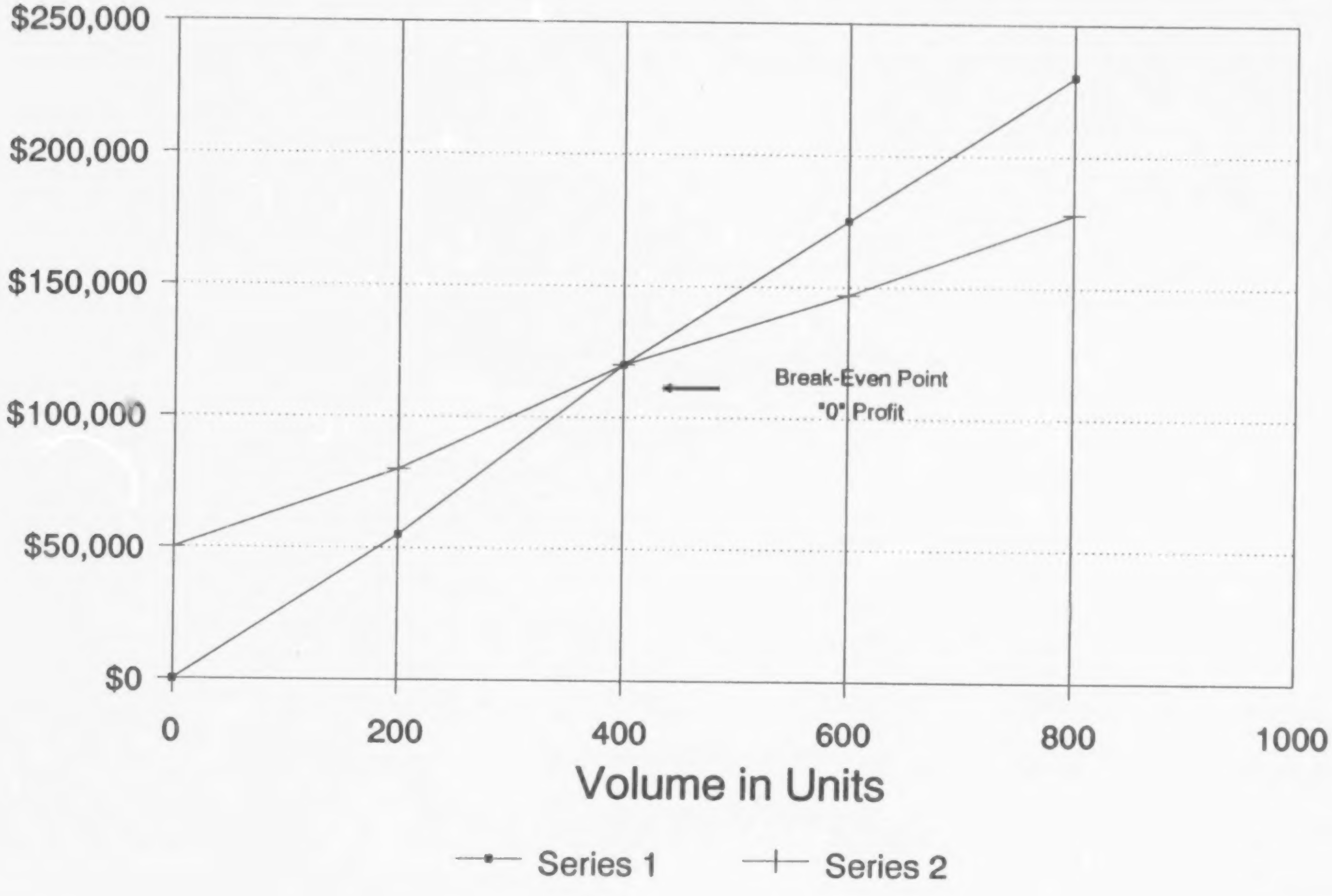
Item	Beginning Inventory	+	Purchases	-	Sales at Cost	=	Ending Inventory
________	________		________		________		________
________	________		________		________		________
________	________		________		________		________
________	________		________		________		________
________	________		________		________		________
________	________		________		________		________
________	________		________		________		________
________	________		________		________		________

TRANSPARENCY MASTER #9

Inventory for Sunrise Chemical and Fertilizer

Quantity	Units	Item Description	Purchase Date	Purchase $/Unit	Purchase Total $	Current $/Unit	Current Total $	Current Location	Identification Number
500	Tons	0-0-62	00/00/00	$160	$80,000	$170	$85,000	Bin 6	
400	Tons	18-46-0	00/00/00	$240	$96,000	$255	$102,000	Bin 8	
300	Tons	0-46-0	00/00/00	$230	$69,000	$240	$72,000	Bin 7	
100	Tons	46-0-0	00/00/00	$200	$20,000	$230	$23,000	Bin 10	
500	Tons	82-0-0	00/00/00	$170	$85,000	$190	$95,000	Tank 2	
400	Gals	Chem X	00/00/00	$60	$24,000	$27	$10,800	Bldg 3	02589208
800	Gals	Chem Y	00/00/00	$70	$56,000	$85	$68,000	Bldg 3	025729078
1000	Gals	Chem Z	00/00/00	$80	$80,000	$95	$95,000	Bldg 2	3490850938
200	Gals	Chem A	00/00/00	$40	$8,000	$50	$10,000	Bldg 2	0392458098
800	Gals	Chem B	00/00/00	$55	$44,000	$65	$52,000	Bldg 2	054023840
750	Gals	Chem C	00/00/00	$65	$48,750	$75	$56,250	Bldg 3	2984502380
750	Gals	Gasoline	00/00/00	$1.05	$787.5	$1.05	$787.5	Plant	
1500	Lbs	Insecticide	00/00/00	$3.00	$4,500	$3.50	$5,250	Bldg 2	
1		4WD Pickup	00/00/00		$15,000		$9,000	Bldg 1	0Q2048028500985408
1		4WD Pickup	00/00/00		$18,000		$14,000	Bldg 1	2039852384502835
1		Pickup Sprayer	00/00/00		$14,000		$7,000	Bldg 1	JF2763724784U68
1		Spray Cart	00/00/00		$12,500		$10,000	Bldg 1	HJ667356873472
1		Big Wheels	00/00/00		$80,000		$45,000	Bldg 1	I91874590127459127
20		Fert Buggies	00/00/00	$1,500	$30,000	$750	$15,000	Plant	
1		Anhydrous Bulk Tank	00/00/00		$25,000		$20,000	Plant	
20		Anhydrous Toolbars	00/00/00	$1,100	$22,000	$600	$12,000	Plant	
40		Anhydrous Tanks	00/00/00	$900	$36,000	$500	$20,000	Plant	
1		Fertilizer Blender	00/00/00		$4,500		$2,500	Plant	TY476474586847
1		Payloader	00/00/00		$16,000		$16,000	Bldg 1	WRTY365783568
1		Utility Tractor	00/00/00		$9,000		$3,000	Bldg 1	9Q0587-2349857098
1		Portable Welder	00/00/00		$6,000		$4,000	Shop	SF27624572678GH45
1		Air Compressor	00/00/00		$2,500		$2,000	Shop	4256234767676245
1		Computer System	00/00/00		$5,000		$5,000	Office	23453245256
3		Office Desks	00/00/00	$500	$1,500	$500	$1,500	Office	
1		Communication System	00/00/00		$15,000		$10,000	Office	23456234256
			Totals		$928,037.5		$871,087.5		

Break-Even Graph



TRANSPARENCY MASTER #10

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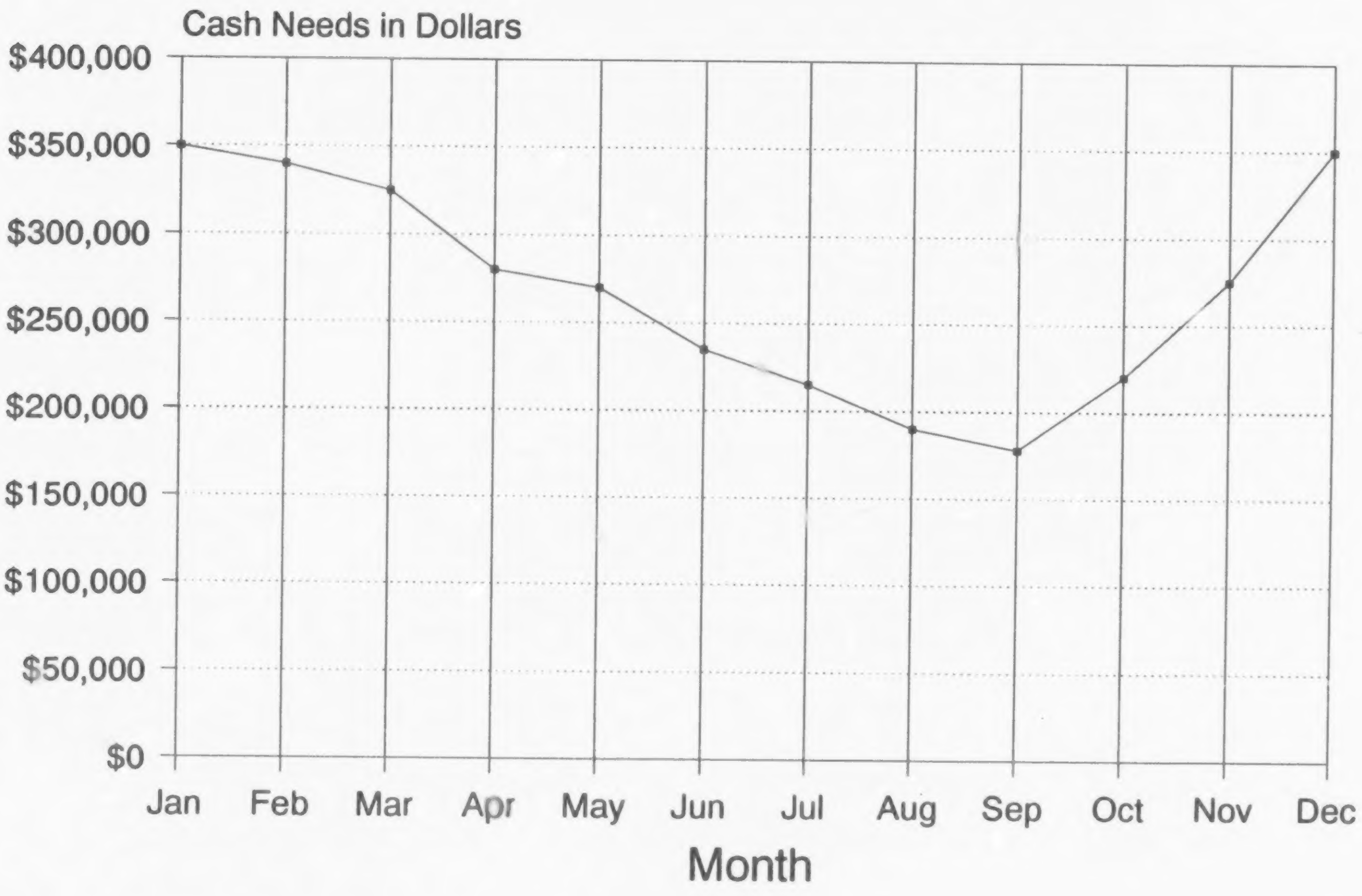
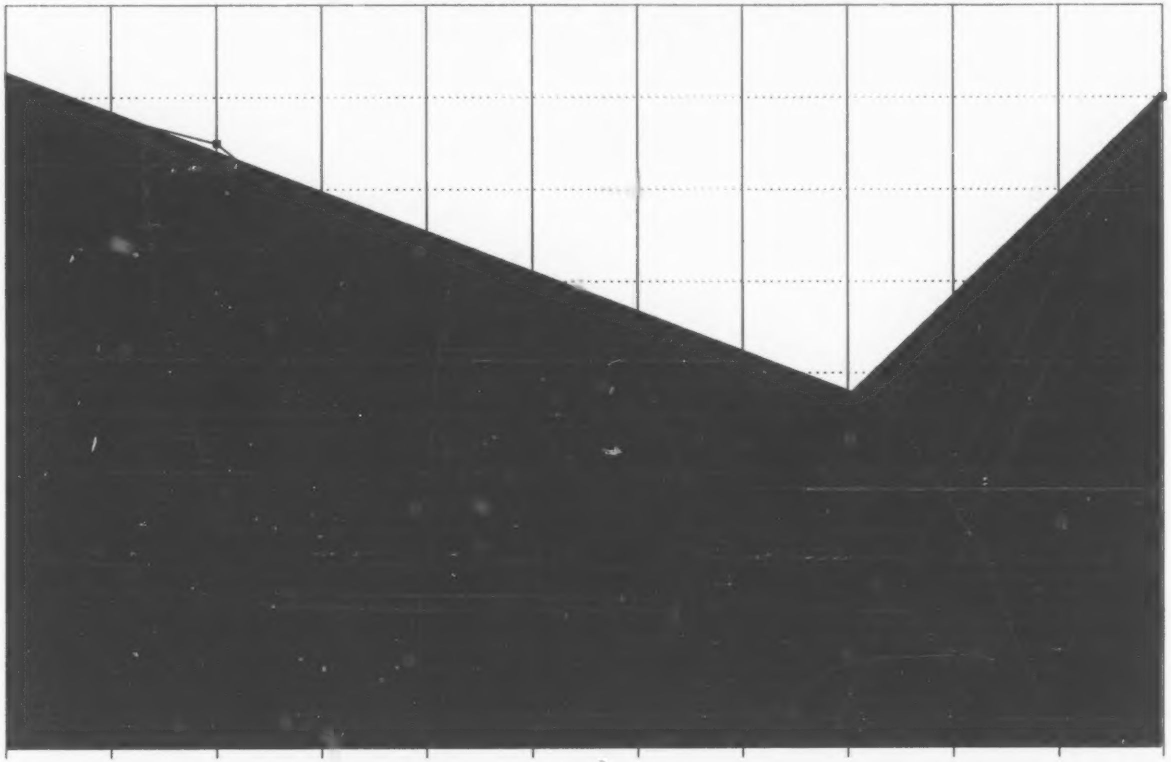
Variation in Cash Requirements For an Agribusiness



Overlay for
Transparency Master #11

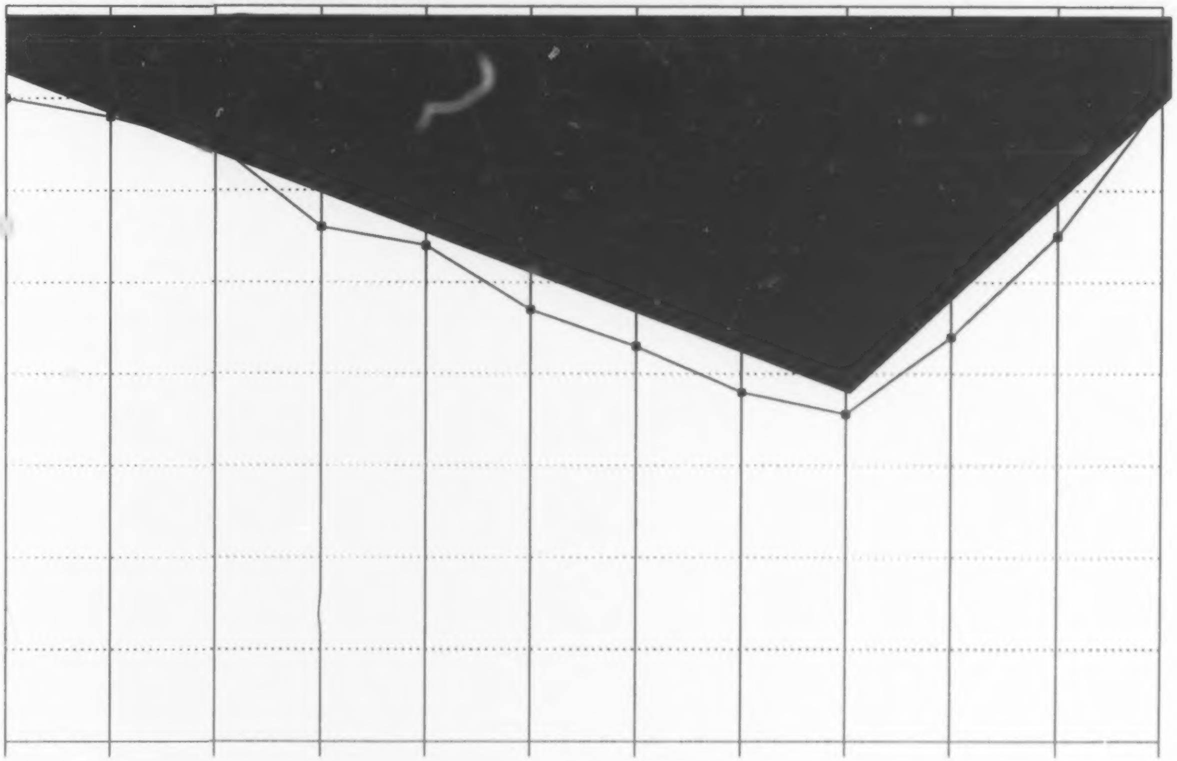
Y,Y Max amount of cash required to meet slack season needs.



Amount to be borrowed to meet peak season requirements.

Overlay for
Transparency Master #11

Z,Z Max amount of cash required to meet peak season needs.



Amount of excess cash on hand not working for Agribusiness.

STUDENT ACTIVITIES

STUDENT WORKSHEET #1 — Preparing a Balance Sheet and a Profit and Loss Statement, and Identifying the Financial Problems of the Agribusiness

STUDENT WORKSHEET #2 — Preparing a Cash Flow Statement

For additional activities, teachers may refer to the "Suggested Teaching Activities and Procedures" section in the Instructor's Guide.

STUDENT WORKSHEET #1

Preparing a Balance Sheet and a Profit and Loss Statement, and Identifying the Financial Problems of the Agribusiness

Given the following information and forms, prepare a balance sheet and a profit and loss statement, and identify the financial problems of the firm.

Assets	
Cash	17,000
Accounts Receivable	30,000
Inventory	52,000
Machinery and Equipment	18,000
Buildings	35,000
Liabilities and Net Worth	
Accounts payable	30,000
Notes payable	22,000
Mortgage	35,000
Net Worth	65,000
Sales	160,000
Cost of goods sold	75% of sales
Operating expense	30,500
Interest expense	4,500

The following ratios should be used to determine the financial problems of the agribusiness.

Liquidity
Solvency
Ownership Equity
Receivables Turnover
Net Working Capital Turnover
Turnover on Total Assets
Return on Assets
Return on Net Worth
Inventory Turnover

STUDENT WORKSHEET #1 — Key

Preparing a Balance Sheet and a Profit and Loss Statement, and Identifying the Financial Problems of the Agribusiness

Balance Sheet

Assets		
Cash	17,000	
Accounts Receivable	30,000	
Inventory	52,000	
Total Current Assets		99,000
Machinery and Equipment	18,000	
Buildings	35,000	
Total Long Term Assets		53,000
Total Assets		152,000
Liabilities and Net Worth		
Accounts payable	30,000	
Notes payable	22,000	
Total Current Liabilities		52,000
Mortgage	35,000	
Total Long Term Liabilities		35,000
Total Liabilities		87,000
Net Worth		65,000
Total Liabilities and Net Worth		152,000

Profit and Loss Statement

Sales	160,000
Cost of goods sold	120,000
Gross Margin	40,000
Operating expense	30,500
Net Operating Profit	9,500
Interest expense	4,500
Net Profit	5,000

Liquidity or Current Ratio $\frac{\text{Current Assets}}{\text{Current Liabilities}} = \frac{\$99{,}000}{\$52{,}000} = 1.9{:}1$

Solvency $\frac{\text{Total Liabilities}}{\text{Net Worth}} = \frac{\$87{,}000}{\$65{,}000} = 1.34{:}1$

Ownership Equity $\frac{\text{Net Worth}}{\text{Total Assets}} = \frac{\$65{,}000}{\$152{,}000} = 0.43{:}1$

Receivables Turnover

$$\frac{\text{Sales}}{\text{Accounts Receivables}} = \frac{\$160{,}000}{\$30{,}000} = 5.3{:}1$$

Net Working Capital Turnover

NWC = Current Assets - Current Liabilities
NWC = $99,000 - 52,000
NWC = $47,000

$$\frac{\text{Sales}}{\text{NWC}} = \frac{\$160{,}000}{\$47{,}000} = 3.4{:}1$$

Turnover on Total Assets

$$\frac{\text{Sales}}{\text{Total Assets}} = \frac{\$160{,}00}{\$152{,}000} = 1.1{:}1$$

Return on Assets

$$\frac{\text{Net Profit}}{\text{Total Assets}} = \frac{\$5{,}000}{\$152{,}000} = 0.03{:}1$$

Return on Net Worth

$$\frac{\text{Net Profit}}{\text{Net Worth}} = \frac{\$5{,}000}{\$65{,}000} = 0.08{:}1$$

Inventory Turnover

Cost of Sales = Sales - Margins = $160,000 - $40,000 = $120,000

$$\frac{\text{Cost of Sales}}{\text{Inventory}} = \frac{\$120{,}000}{\$52{,}000} = 2.3{:}1$$

Problems are with:

1. Solvency — for every dollar of net worth there is $1.34 of liabilities. Lenders like this ratio to be at least 1 to 1.
2. Ownership Equity — If less than 50% of total assets is covered by net worth, it is difficult to get a loan.
3. Return on Assets — quite low. It would seem assets could be used to generate greater return.
4. Return on Net Worth — How does this compare to current rates of return on other possible investments of owner's equity? Keep in mind the risk factors.
5. Inventory Turnover — Depending on the industry, these could be quite low or average. A high volume/low profit business would see this as low whereas a machinery dealership that is low volume/high markup might see this as adequate.

STUDENT WORKSHEET #2

Preparing a Cash Flow Statement

Each student will prepare a cash flow statement for a fertilizer business using the forms and data provided by the instructor.

The date represents figures for one year and must be divided into twelve periods because of the seasonal nature of agriculture.

STUDENT WORKSHEET #2 — Key

Preparing a Cash Flow Statement

This is a difficult assignment to grade. It will depend on how students divide up the total amount given for each category. The students could divide each total by twelve, but this would not be a true picture of actual events due to the seasonal nature of agriculture.

It is recommended that the students prepare the cash flow using pencil and paper first. If you wish, use Transparency Master #3 as a guide for preparing your own computer spread sheet using your favorite spread sheet program.

The totals used for Student Worksheet #2 are *not* provided. It is felt that if the instructor has to grade this assignment and work with the students in completing this assignment that the instructor should prepare the totals which would improve the instructor's understanding and clarity. You should find Transparency #3 very helpful.

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Understanding Agricultural Law Applications

RELATED PROBLEM AREAS:

1. Recognizing the Role of Agriculture in Society (Central Core Cluster)
2. Understanding the Relationship Between Agriculture and the Environment (Central Core Cluster)
3. Identifying and Practicing Ethics in Agricultural Occupations (Central Core Cluster)
4. Insuring the Agribusiness
5. Understanding Government Regulations and Controls (Agricultural Resources Cluster)
6. Managing Freshwater Resources (Agricultural Resources Cluster)

PREREQUISITE PROBLEM AREA(S): None

LEVEL: Preparatory

OCCUPATIONAL TASKS ADDRESSED:

Agricultural Business and Management Cluster

Duty B: Performing Sales Duties

1. Explain federal and state laws regarding the grain elevator business
2. Explain legal responsibilities of businesses which deal with interstate commerce

Duty C: Performing Sales-Related Duties

1. Label seed in accordance with state law

Duty K: Maintaining and Constructing Structures

1. Perform maintenance inspection of facilities

Duty R: Applying Safety Practices

1. Comply with shop and equipment safety rules
2. Apply basic emergency first-aid techniques
3. Complete accident report
4. Inspect work area and equipment for safe work environment
5. Use fire extinguishers
6. Correct safety hazards
7. Demonstrate cardiopulmonary resuscitation (CPR)
8. Comply with safety requirements for working around automated systems
9. Participate in safety training programs

Agricultural Resources Cluster

Duty B: Applying Laws, Regulations, and Policies

1. Interpret visitor disciplinary processes
2. Interpret game and wildlife laws
3. Interpret stream, lake, pond. and groundwater laws
4. Patrol work areas
5. Request visitors to voluntarily comply with rules and regulations
6. Process visitor complaints
7. Report violations to appropriate authority
8. Interpret Environmental Protection Agency (EPA) regulations
9. Maintain permits, certificates, and licenses
10. Maintain crowd control
11. Direct vehicular and pedestrian traffic
12. Greet and meet people
13. Prepare service work order
14. Estimate cost of service work
15. Post facility directions and warnings
16. Post facility rules and regulations
17. Monitor camping and swimming areas
18. Maintain wildfire protection lanes
19. Maintain facility sanitation

Duty H: Apply Safety Practices

1. Assist with search and rescue operations
2. Implement plans to protect visitors from dangerous animals and other hazards
3. Implement plans to protect animals and plants and other resources from visitors
4. Store flammable and other hazardous materials safely
5. Monitor equipment for safe operation
6. Maintain shields, guards, and other safety devices on tools and equipment
7. Comply with Occupational Safety and Health Administration (OSHA) safety standards
8. Complete accident or injury reports

STATE GOALS FOR LEARNING

In planning the instruction for this problem area, teachers can promote the development of several student learning objectives which are related to the State Goals for Learning in Language Arts and Social Sciences. These objectives are listed on the Learning Assessment Plan forms included on the following page(s). Those learning objectives marked with an asterisk (*) are taken from the sample lists provided by the Illinois State Board of Education.

Illinois Agricultural Core Curriculum
Agricultural Education 124 Mumford Hall 1301 W. Gregory Drive University of Illinois Urbana, IL 61801

Director: Dale A. Law, Ed.D.
Principal Investigator: Jerry D. Pepple, Ed.D.
Research Assistant: James K. Shinn

Illinois Agricultural Core Curriculum Rev.

Agricultural Business and Management
Agribusiness Operation and Management

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date ____________
☐ Original submission ☐ Revision
Page ____ of ____

I. LEARNING AREA *(check one)*
☒ Language Arts
☐ Mathematics
☐ Sciences
☐ Fine Arts
☐ Social Sciences
☐ Physical Development/Health

(Affix label or complete district information.)
COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐
District Name
City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to understand how and why language functions and evolves.

Contact Person: ____________
Title: ____________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	V. EXPECTATIONS Percent of Students Expected to Achieve Objective
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:					
*1. Understand the purposes being met by a specific message.					
*2. Draw conclusions from all forms of communications.					
3. Discuss orally, in class, the various penalties for failure to comply with laws.					
4. Identify why laws are necessary.					

ISBE 41-78 (1/88)

Understanding Agricultural Law Applications

Submission Date ____________
☐ Original submission ☐ Revision
Page _____ of _____

I. LEARNING AREA *(check one)*
☒ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☐ Sciences ☐ Physical Development/Health

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

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(Affix label or complete district information.)
COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐
District Name
City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to write standard English in a grammatical, well-organized, and coherent manner for a variety of purposes.

Contact Person: ____________
Title: ____________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Focus clearly upon one central idea or event when writing.					
*2. Use descriptive details, reasons for an opinion, concrete examples of solutions to a problem, and/or an authority's viewpoint to support the main idea.					
*3. Support and elaborate the main point with specific information or reasons.					
4. Prepare a paper of at least 500 words in which students demonstrate their ability to think critically and resolve a complex issue taking many factors into consideration.					
5. List, give an example of, and explain the four different types of laws which an agricultural business must be in compliance with.					

ISBE 41-76 (1/88)

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

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Submission Date ____________
☐ Original submission ☐ Revision
Page ____ of ____

I. LEARNING AREA *(check one)*
☒ Language Arts
☐ Mathematics
☐ Sciences
☐ Fine Arts
☐ Social Sciences
☐ Physical Development/Health

(Affix label or complete district information.)
COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐
District Name
City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to read, comprehend, interpret, evaluate, and use written materials.

Contact Person: ____________
Title: ____________
Phone: ( )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Use, synthesize, and analyze information from a variety of sources to enhance understanding, e.g., from opinions based upon a variety of information, to compare and contrast, to verify information, and to expand knowledge.					
2. Identify the major differences between ethics and laws.					
3. Name and describe the four sources of laws.					

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ISBE 41-78 (1/88)

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date ____________
☐ Original submission ☐ Revision
Page ____ of ____

I. LEARNING AREA *(check one)*
☐ Language Arts
☐ Mathematics
☐ Sciences
☐ Fine Arts
☒ Social Sciences
☐ Physical Development/Health

(Affix label or complete district information.)
COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐
District Name
City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to apply the skills and knowledge gained in the social sciences to decision making in life situations.

Contact Person: ____________
Title: ____________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Apply a rational decision-making process based on goals, values, and needs to selected consumer and social problems.					
*2. Evaluate the costs and benefits of a particular course of action.					
*3. Compare the economic interdependence among agriculture, business, government, labor, and the consumer.					
*4. Know how to use the various levels of government.					
*5. Distinguish between rights and responsibilities of employers and workers in the workplace.					
6. Identify where the rights of an individual or group begin and end in relation to another individual or group.					
7. Determine when ethical behavior is appropriate in contrast with legal requirements.					

ISBE 41-78 (1/88)

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Understanding Agricultural Law Applications

STUDENT LEARNING OBJECTIVES

Upon completion of their study of this problem area, students will be able to:

1. Identify the major differences between ethics and laws.
2. Determine when ethical behavior is appropriate in contrast with legal requirements.
3. Identify where the rights of an individual or group begin and end in relation to another individual or group.
4. Identify why laws are necessary.
5. Name and describe the four sources of laws.
6. Name and describe the various types of laws.
7. Discuss orally, in class, the various penalties for failure to comply with laws.
8. List, give an example of, and explain the four different types of laws which an agricultural business must be in compliance with.
9. Prepare a paper of at least 500 words in which students demonstrate their ability to think critically and resolve a complex issue taking many factors into consideration.
10. Apply knowledge and skills learned in this problem area to daily behavior at work, in school, and in the community.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Understanding Agricultural Law Applications

PROBLEMS AND QUESTIONS FOR STUDY

INSTRUCTOR'S NOTES AND REFERENCES

1. What do we mean when we say someone is ethical?
2. How can someone be legally right and ethically wrong?
3. Why do we have laws?
4. How do laws originate?
5. What are the four major sources of laws?
6. How do we determine where the rights of an individual or group begin and end?
7. How do laws designed to control business differ from laws designed for individuals?
8. What are some of the penalties for failure to abide by laws?
9. How do businesses become aware of new laws that affect their operation?
10. What requirements must managers meet with the employee's "Right To Know"?
11. How do employers inform their employees about laws that may affect their safety?
12. What is critical thinking?
13. How is critical thinking used to resolve complex problems?
14. How might critical thinking be used in everyday decision making?

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Understanding Agricultural Law Applications

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES

1. Begin the development of the problem area by drawing a concensus opinion of the definitions for ethics and laws from class discussion. These should be the student's definitions, not dictionary or expert definitions. Probing questions to be used to stimulate discussion might include:
   a. What do we mean when we say someone is an ethical person?
   b. What do we mean when we say someone is a law-abiding citizen?
   c. Can a person be ethical and not law-abiding? Why or why not?
   d. Can a person be law-abiding and not ethical? Why or why not?

   Ask for specific examples to clarify responses.

2. Continue development of the problem area by dividing the class into two groups.
   a. Group one, using the definition of ethics in class, will prepare a brief paragraph in support of the following: "If everyone were ethical we would not need laws."
   b. Group two, using the definitions of laws developed in class, will prepare a brief paragraph in support of the following: "Everyone is out to make a profit anyway they can, so we need laws to control the population."

   You may also choose to keep the topics for the paragraph secret so that only the group developing the paragraph will know the topic until the two groups are drawn together for discussion.

   After about ten minutes draw groups together to present their paragraphs. Ask for discussion, both pro and con, on the issues addressed. This should be an excellent opportunity for students to do some critical thinking on where the lines should be drawn on issues facing agricultural business today with regard to what is legal or ethical in business.

3. To stimulate discussion on the possible conflicts of different individuals' rights, ask the following questions:
   a. Where do the rights of one individual, group of individuals, business, or country begin and end?
   b. Who determines where the lines are drawn?

4. After completion of one or more of the class activities above it should become evident that there are many reasons why laws exist. A discussion at this time on sources of laws and how laws are made from the local level to the national level would bring activities above to a meaningful conclusion.

   Use of the spider map (Transparency Master #1) can show sources of input which result in laws being made.

5. At this point it would be appropriate to have an attorney, city council representative, or judge visit the class and discuss the various types of laws which are particularly relevant to agricultural businesses, how and why they came about, and penalties for failure to adhere to the laws.

   You may also wish to coordinate the visit with your social studies instructor to draw parallels between laws of particular concern to agricultural businesses and laws that affect the general public.

6. A visit by a respected owner/manager of a successful agricultural business in your community to the classroom or a field trip to the agribusiness is recommended so that a talk on the various types of and specific laws regulating all phases of the operation can be presented.

   You may wish to prepare in advance a list of laws which you would like the agricultural business owner/manager to discuss in relation to that specific agricultural business. See Information Sheet #6 for list of laws.

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Understanding Agricultural Law Applications

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES (Con't.)

7. A case study has been included in this problem area to assist students in drawing this problem area to a close. The case study requires that students incorporate a great deal of critical thinking to resolve an issue which addresses many concerns. The amount of time spent on critical thinking methodology prior to this assignment will have a great deal of effect on the quality of the assignment. Open discussion of critical thinking techniques before and after the assignment is completed is strongly recommended.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Understanding Agricultural Law Applications

REFERENCES

INSTRUCTOR'S NOTES AND REFERENCES

*1. *Nursery Management, Administration and Culture.* (1988). Davidson, H., Mechlenburg, R., Curtis, P. 2nd edition. Prentice Hall, Englewood Cliffs, NJ 07632.

2. *Occupational Education and Technology.* (1987). Texas Education Agency, 1701 N. Congress, Austin, TX 78701. (512) 463-9734.

*3. *Agricultural Laws and Regulations.* (Subject Matter Unit #8711-B). Instructional Materials Service, Texas A & M University, P.O. Box 2588, College Station, TX 77843-2588.

4. *Notice to Employers and Employees.* (1988). Illinois Department of Labor, 310 S. Michigan Avenue, 10th Floor, Chicago, IL 60604.

5. *Notice to Workers about Unemployment Insurance Benefits.* (1988). Illinois Department of Employment Security. (Office located throughout the state). (800) 732-8866.

6. *Six Day Work Law.* (Publication #253). (1989). State of Illinois, Department of Labor, 310 S. Michigan Avenue, Chicago, IL 60604. (800) 654-4620.

7. *Minimum Wage and Overtime Law.* (1988). State of Illinois, Department of Labor, 310 S. Michigan Avenue, Chicago, IL 60604. (800) 654-4620.

*Indicates highly recommended reference

INSTRUCTIONAL RESOURCES

These resources are intended for use by teachers in planning and teaching the materials for this problem area and may be adapted to fit the teaching method(s) used.

INFORMATION SHEET #1 — Constant State of Change

INFORMATION SHEET #2 — Terms to be Defined

INFORMATION SHEET #3 — Agricultural Chemical Laws and Health and Safety Regulations

INFORMATION SHEET #4 — Legal Liabilities and Negligence

INFORMATION SHEET #5 — Laws Come From Many Sources

INFORMATION SHEET #6 — Three Types of Laws

INFORMATION SHEET #7 — Fair Labor Standards

INFORMATION SHEET #8 — The Chemical Spill (A Case Study)

INFORMATION SHEET #9 — Safety Phase I and Booklet

TRANSPARENCY MASTER #1 — Laws Come From Many Sources

TRANSPARENCY MASTER #2 — Critical Thinking Is:

INFORMATION SHEET #1

Constant State of Change

It is important to remember that laws at all levels of government, from the local community to international laws, are in a constant state of change and revision. This problem area is in no way intended to cover all issues or give legal advice. You are encouraged to have an attorney or judge speak to your classes on specific issues concerning laws in your local area and how they affect agricultural businesses.

You may also wish to have a local agricultural business person speak on how he or she is made aware of new or changing laws and what is required to come into compliance with the new laws.

INFORMATION SHEET #2

Terms to be Defined

Ethics — the standards of behavior or conduct that society sets and expects of individuals and businesses. Included are moral standards, ideals, and principles.

Laws -- legal responsibilities that hold an individual or company personally responsible for actions and behaviors.

Precedent — a prior act, decision, or legal judgement that serves as a basis for justification of future decisions.

Statutory Law — written law as distinguished from unwritten or common law.

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INFORMATION SHEET #3

Agricultural Chemical Laws and Health and Safety Regulations

Chemical Laws

Federal regulations require specific care when handling or using chemicals which can kill a living organism. These regulations are concerned with:

1. Careful testing and proper experimentation before use.
2. Compliance to Federal and State laws.
3. Accurate labeling with specific uses listed for each product.

State laws vary widely with regard to the handling and use of chemicals and drugs. In most states today some form of certification is required before persons are permitted to use chemicals or drugs. It is important to remember that many, if not all, chemicals and drugs have the capability to kill or at least severely damage living organisms. Caution should always be exercised and checking with state agencies relative to the chemical or drug you intend to use is vital. Liability here can ruin an individual and/or business.

Health and Safety Regulations

All agricultural businesses are affected to some degree by health and safety regulations. These regulations may be designed to protect employees and customers but more generally they are designed to protect the community at large. The degree and amount of regulation is directly tied to the activities of the agricultural business. For example: Businesses involved with any product for human consumption will have some of the most stringent regulations.

Zoning regulations are also generally designed to protect the health and safety of the community in which an agricultural business is located. For example, if a business handles a chemical which could potentially pollute a community's water supply, land made available for such a business must be zoned for that particular purpose.

INFORMATION SHEET #4

Legal Liabilities and Negligence

Legal Liabilities

Of particular concern to agricultural businesses are the laws relative to who is responsible or liable for injury, either personal or property, and therefore must pay damages as determined by the courts. Insurance to protect agricultural businesses against such judgments is one of the largest expenses of operating an agricultural business.

Negligence

In most situations the liability of an agricultural business must be determined based on negligence. It must be proven that injuries sustained are the result of negligence which is the action or lack of action on the part of the agricultural business to prevent such injury. Courts have said that negligence is the disregard by an individual to do something which a "reasonable person" would do under a similar situation. Negligence can also be the failure to use normal care.

Liabilities of Employees

Employers may be liable for the acts of people they hire or injuries to the employees. It is therefore the employer's responsibility to:

1. Make reasonable rules for safe conduct of employees while they are at work.
2. Provide a safe place to work.
3. Provide competent fellow employees.
4. Provide reasonably safe tools, equipment, and machinery.
5. Warn and instruct employees of dangers they may not reasonably be expected to discover.

INFORMATION SHEET #5

Laws Come From Many Sources

The four general sources of laws are:

1. Custom (people) — Ways in which people act over an extended period of time may become the accepted standard of conduct and often become statutory law. Courts may refer to these to settle disputes between individuals, businesses, or countries. Statutory law becomes "common law" or what is considered common practice.
2. Judges (courts) — The decisions of judges based on opinions become part of the court's records. Other judges may refer to these opinions in court records to settle disputes of a similar nature. Because of continued use of these decisions, which serve as precedents, a common law is established.
3. Lawmaking bodies (legislative bodies) — City, state, and federal bodies are empowered to create statutes and laws that affect entire populations.
4. Administrative rules (government) — regulatory bodies within the government pass rules which people and the courts give strength to. The Williams-Steiger Occupational Safety and Health Act of 1970 is an example. Occupational Safety and Health Act "assures so far as possible, every working man and woman in the nation safe and healthful working conditions and to preserve our human resources." This act must then be interpreted to fit the particular conditions within each type of agricultural business.

INFORMATION SHEET #6

Three Types of Laws

Local Laws

Communities establish ordinances or laws that regulate certain activities of the agricultural businesses. These ordinances or laws may include the requirement of the business to acquire licenses and permits or to pay fines. Such ordinances or laws may also restrict noise, odors, various forms of pollution, waste products, waste water used in processing, disposal of trash, and storage of products or equipment. Taxes of various types are also imposed by law and may come in several forms such as sales and use taxes.

Zoning laws may also be established with regard to improvements or additions to the property or facilities where an agricultural business is located. A uniform code helps prevent serious injury or damage due to improper construction, electrical work, or plumbing. Building codes and inspections become necessary to assume proper work is being done.

State Laws

In addition to local laws already in force, states may impose restrictions on agricultural business operations. Laws which affect minimum age of employees, operation of equipment on state routes, taxes, permits, licenses, and various forms of worker insurance or compensation are examples of state laws. Many more exist which are unique to the individual states and types of agricultural businesses.

Federal Laws

Federal laws may be similar to state laws in many respects but generally will cover a much larger portion of the population. Examples of federal laws and what they regulate include:

1. Federal Income Taxes.
2. Social Security.
3. Labeling of restricted materials.
4. Interstate commerce.
5. Sanitation and health standards with regard to food.
6. Use, storage, and handling of toxic materials.
7. Working conditions.
8. Assurance of free enterprise in market practices and pricing.
9. Labor union rights.
10. Overall management of the business depending on the type of organization. The degree of control varies depending on whether the business is a single proprietor, partnership, corporation, or cooperative.

INFORMATION SHEET #7

Fair Labor Standards

There are many laws imposed upon agricultural businesses by state and federal governments, in particular, laws regarding Fair Labor Standards. Some examples are:

State of Illinois Department of Labor:

1. *Six Day Work Law* — includes twenty-four hours of rest in every week except with special exemptions as may be needed due to seasonality of work, responsibilities of employers, and meal periods.
2. *Minimum Wage and Overtime Law* — includes ride-sharing arrangements, minimum wages, prohibiting of sex discrimination, overtime compensation, wages for individuals whose capacity is impaired by age or physical or mental deficiency, wages for learners, record keeping requirements, posting of Acts and Regulations and legal action available to employees.
3. *Child Labor Laws* — includes age of minors, work schedule for minors, hazardous occupations.
4. *Prevailing Wage Act* — includes preference to Illinois citizens and arbitration service.

Other laws enforced by the Department of Labor of Illinois are:

1. Toxic Disclosure Act
2. Private Employment Agencies Act
3. Strict Trades Law
4. Farm Labor Contractor Certification
5. Personnel Records Review Act

State of Illinois Department of Employment Security:

Monitors unemployment insurance benefits and reporting of tips.

INFORMATION SHEET #8

The Chemical Spill (A Case Study)

The case study presented in Student Worksheet #1 is designed to introduce students to some ways of examining an issue using critical thinking. The use of critical thinking to examine an issue as presented here may be very new to many of your students. However, with some effort it should become clear that what they learn here can be used in the "real world."

You may choose to use the entire case study at one time or separate it into smaller chunks addressing only one or two issues at a time. No matter which method you choose, it is felt that to receive the greatest benefit from this case study an open discussion in class about the possible solutions is necessary.

There are many possible solutions based on assumptions made by the students but, as in the case study itself, support will be needed to justify any solutions. Some possible alternative ways to handle discussion are:

1. Each person defends his or her own position.
2. Groups of 2 or 3 people take a position and defend it.
3. Take people with similar positions and group together and have them develop support.
4. Try to get the class to arrive at one or two possible positions that seem best and write a second paper defending one of these positions.
5. After defending their positions in class orally, have students rewrite their papers to defend their positions more strongly, based on what was learned in the oral discussion.

It is important that the discussion be drawn to a conclusion by showing and stressing how the assignment can carry over into real life situations involving everyday activities in such areas as:

1. Responding to a sales presentation or advertisement.
2. Political issues.
3. The creation of new laws.
4. Ways in which one can make a strong point for or against an issue.
5. Deciding what to accept or believe in school, in the newspaper, on news programs or through conversations and rumors.

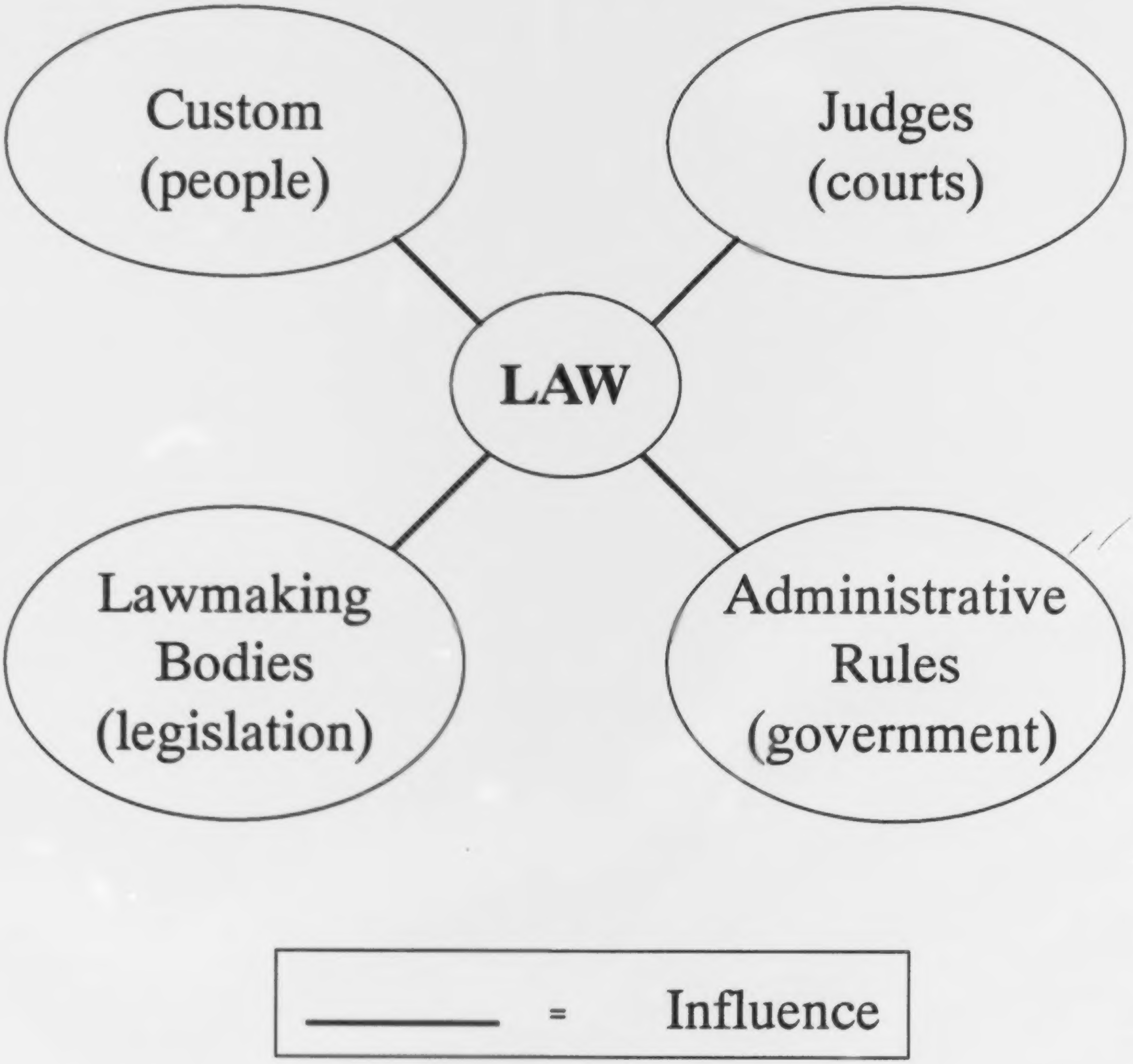
INFORMATION SHEET #9

Safety Phase I

The *Safety Phase I* booklet (obtained from Growmark, P.O. Box 2500, Bloomington, IL 61702-2500, (309) 557-6000.) was originally placed in the problem area as an example of how agricultural businesses assist their employees in becoming familiar with new laws that concern the employees. The booklet should not, under any circumstances be considered up-to-date. It is only one example, and up-to-date materials should be acquired if you intend to make this a required portion of this lesson plan.

TRANSPARENCY MASTER #1

Laws Come From Many Sources



Custom (people)

Judges (courts)

LAW

Lawmaking Bodies (legislation)

Administrative Rules (government)

——— = Influence

TRANSPARENCY MASTER #2

Critical Thinking Is:

Reasonable reflective thinking focused on deciding what to believe or do.

Critical Thinking Involves the Ability To:

1. Identify when there is conflict of interest between material being presented and reasons for the presentation.
2. Identify when expressed or implied assumptions are made which, if accepted by others, would change those others' opinions about the matter at hand.
3. Determine what points are conclusions drawn from information presented, and what are only assumptions or implications.
4. Determine if reasons given are really in support of a conclusion or detract from the support.
5. Identify when a generalization has been made which is not appropriate to the issue at hand.
6. Determine when facts presented are relevant and when they are not.
7. Identify when conclusions drawn do not necessarily follow from reasons given.
8. Determine what possible alternative conclusion(s) could result from facts versus assumptions or implications and decide which alternative conclusion(s) would be reasonable.

Refer to:

1. *Reasonable Reflective Thinking Focused on Deciding What to Believe or Do.* Ennis, R.H. (1985, 1987) and *Critical Thinking and the Curriculum.* Ennis, R.H. (1985). National Forum, 65 (1), (pp. 28-31).
2. *A Taxonomy of Critical Thinking Dispositions and Abilities.* Baron, J.B., Sternberg, R.J. (1987) and *Teaching for Thinking*, Freeman, New York, NY. (pp.9-26)

STUDENT ACTIVITIES

STUDENT WORKSHEET #1 — The Chemical Spill

For additional activities, teachers may refer to the "Suggested Teaching Activities and Procedures" section in the Instructor's Guide.

STUDENT WORKSHEET #1

The Chemical Spill

The broad aim of this assignment is to develop critical thinking skills.

Aniticipated Outcomes:

Students will be able to:

1. Identify conflicts of interests and their effects on an argument.*
2. Identify assumptions being implied and their effects on the argument.
3. Determine when arguments are deductively valid.
4. Determine if reasons given in support of an argument are relevant to that argument.
5. Determine if generalizations made in support of an argument apply to the general population.
6. Determine which facts are relevant to the argument and which are not.
7. Identify conclusions which do not necessarily follow from the reasons given.
8. Make specific recommendations, after considering possible alternatives, to resolve issues in a satisfactory manner.

* The term **argument** as used throughout this case study refers to the presentation of facts, opinions, assumptions, or implied facts offered in support of a conclusion.

Specific Objectives:

After careful examination of the case, each student will prepare a paper of not less than 1,500 words to be handed in, recommending what actions the city council should take to resolve the issues before them.

Each student must be prepared to take an active part in a discussion of the case defending the position the student has taken in his or her paper.

In order to prepare for the specific objectives of this assignment students should address the following critical issues:

1. Are there conflicts of interest that weaken the arguments of individuals or groups? If so, identify them and tell why you believe the arguments are weakened.
2. Are there assumptions being implied which are not valid? If so, what are they and why are they not valid?
3. Which concerns or parts of concerns expressed are valid and why?
4. Are there reasons being given to support an argument which are irrelevant? If so, list and explain why they are irrelevant.
5. Are there generalizations or claims which are inappropriate? If so, list and explain why you feel as you do.
6. Have facts been presented which override concerns expressed? If so, what are the facts and why do you feel as you do about these facts?
7. Are conclusions drawn which do not necessarily follow from the reasons given? If so, what are they and why don't they necessarily follow?
8. What is/are your recommendation(s) and what support do you offer?
9. Are there alternative solutions which you have ruled out? What are they and why have you ruled them out?

The Situation:

There has been a fairly large chemical spill in your home town. The local fertilizer plant located just inside the city limits is where the chemical spill occurred. No one was injured but some of the chemical may have gotten into the city's water supply. Testing of the water will have to be done for some time to be sure that the water remains safe. Clean up of the spill involves a considerable amount of work and expense at the fertilizer plant as well as on the road and ditch that runs past the plant.

The fertilizer plant owner/manager says the plant will take care of the cleanup and share in the expenses but feels that the local community should also share in the expenses. The plant owner/manager points out that, "After all, it was an accident and the entire community does benefit from the services provided by the fertilizer plant so the community should share in the expense of the clean up."

The state Environmental Protection Agency says the spill must be cleaned up NOW and the fertilizer plant must pay all costs of the clean up.

The city council has called a special meeting to listen to concerns expressed by anyone wishing to appear.

The fertilizer plant owner/manager went before the council to explain that if she must bear the cost alone it will bankrupt the company, and the community will lose the following benefits:

1. A viable, tax-paying business, taxes that support schools, city services, and welfare and aid programs.
2. A strong supporter of community activities.
3. A good employer of community residents.
4. The sponsor of last year's state softball championship team.
5. The only local source of fertilizer and chemicals for area farmers as well as a supplier of fertilizer and chemicals for community residents.

The city does not currently have a policy for the issue at hand because this kind of thing has never happened before.

The Citizens United for a Chemical Free Environment have presented the council with a petition signed by about one third of the registered voters in the community. The petition states that, "We the undersigned are concerned about the health of everyone and believe that no one should ever have to be subjected to toxic chemicals. Therefore we demand that the city take the following action so that no one will ever be exposed to toxic chemicals that cause cancer, brain damage, disfigurement, birth defects, sterility and destruction of our natural resources. We also demand that the fertilizer plant pay all costs relative to the chemical spill because the spill and its effects are due to the negligence of the fertilizer plant and its employees. No one should have to pay for the negligence of someone else."

Actions to be taken (as demanded by *The Citizens United for a Chemical Free Environment*):

1. Ban further use, storage, or transport of any chemicals within the city limits.
2. Require the fertilizer plant to pay all costs associated with the spill and the costs to monitor the city's water supply.

A check of the signatures on the petition indicates that the majority of those signing the petition are registered voters for the local opposition party.

The area farmers, although not organized into a formal group, have expressed a general statement that urges the need for the continued survival of the fertilizer plant in order that the farmers can continue to operate. They have also expressed to the council that they too are tax-paying businesses that contribute a significant amount to the annual income of the city.

Some critical concerns specific to this case which you must address are:

1. How will the city council decision affect the community, the fertilizer plant, and the political futures of the council members?
2. Did the fertilizer plant owner/manager have the best interests of the community in mind when she went before the council? Does she have the right to expect assistance from the city? Who should bear the cost of continued water testing?
3. Which of the concerns are legal matters, which are ethical matters? Are some matters both legal and ethical? Are some concerns trivial? List and explain.

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Insuring the Agribusiness

RELATED PROBLEM AREAS:

1. Understanding Basic Business Organization (Central Core Cluster)
2. Understanding the Relationship Between Agriculture and the Environment (Central Core Cluster)

PREREQUISITE PROBLEM AREA(S): None

LEVEL: Preparatory

OCCUPATIONAL TASKS ADDRESSED:

Agricultural Business and Management Cluster

Duty F: Financing the Agribusiness

1. Calculate insurance needs
2. Calculate the operating expenses

Duty A: Managing the Business

1. Calculate payroll deductions

Horticulture Cluster

Duty D: Applying Fertilizer and Chemicals

1. Determine insurance coverage needs

STATE GOALS FOR LEARNING:

In planning the instruction for this problem area, teachers can promote the development of several student learning objectives which are related to the State Goals for Learning in Social Sciences. These objectives are listed on the Learning Assessment Plan forms included on the following page(s). Those learning objectives marked with an asterisk (*) are taken from the sample lists provided by the Illinois State Board of Education.

Illinois Agricultural Core Curriculum

Agricultural Education 124 Mumford Hall 1301 W. Gregory Drive University of Illinois Urbana, IL 61801

Director: Dale A. Law, Ed.D.
Principal Investigator: Jerry D. Pepple, Ed.D.
Research Assistant: James K. Shinn

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Submission Date ____________
☐ Original submission ☐ Revision
Page ____ of ____

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☐ Mathematics ☒ Social Sciences
☐ Sciences ☐ Physical Development/Health

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)
COUNTY DISTRICT ESC
District Name
City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to apply the skills and knowledge gained in the social sciences to decision making in life situations.

Contact Person: ____________
Title: ____________
Phone: ( )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Understand how employers, labor unions, managers, and workers interact with one another to achieve a common goal.					
*2. Understand the economic roles of the individual in society.					
*3. Apply the principles of comparative pricing to real life situations.					
*4. Apply a rational decision-making process based on goals, values, and needs to selected consumer and social problems.					
*5. Evaluate the costs and benefits of a particular course of action.					
*6. Distinguish between rights and responsibilities of employers and workers in the workplace.					

ISBE 41-78 (1/86)

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Insuring the Agribusiness

STUDENT LEARNING OBJECTIVES

Upon completion of their study of this problem area, students will be able to:

1. Explain the concept of risk.
2. Explain the relationship between risk and insurance.
3. Explain how, through the calculations of odds, insurance companies are able to operate at a profit.
4. Discuss what insurance is *not* supposed to do.
5. List the criteria necessary to be met for the agribusiness owner/manager to be reasonably certain the agribusiness is properly insured.
6. List those factors which are of major importance that must be considered when selecting an insurance agent and insurance company.
7. Explain why price is not the only consideration when selecting insurance and list the additional considerations in the selection process.
8. List and explain each of the three broad categories of insurance.
9. Given a particular type of agribusiness, list and explain at least three unique characteristics of that agribusiness that may require special insurance.
10. List and explain at least five specific types of insurance which agribusinesses generally carry or are required by law to carry.
11. List and explain at least three specific types of insurance that agribusinesses may carry to cover certain individuals within the business.
12. Explain the procedure to follow when an event occurs which may involve the agribusiness's insurance coverage.

INSTRUCTOR'S NOTES AND REFERENCES

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INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Insuring the Agribusiness

PROBLEMS AND QUESTIONS FOR STUDY

1. What are the two major types of risk and how do they differ?

2. What changes have occurred in society throughout the history of the world that could have resulted in the need/requirement for insurance?

3. What is meant by insurance companies playing the "odds"?

4. What are policy limits and how should they be determined?

5. In dealing with insurance agents why is honesty the best policy?

6. What, if any, responsibilities is an agribusiness relieved of as a result of becoming insured?

7. How does buying insurance differ from being self-insured, and under what circumstances would an agribusiness select one over the other?

8. What is the insurance agent's role?

9. Define each of the following as they relate to agribusiness:

   a. Property and liability package policies.
   b. Business interruption insurance.
   c. Marine and inland marine insurance.
   d. Product and professional liability insurance.
   e. Motor vehicle insurance.

10. As an employer, what types of insurance are you required to provide for your employees?

11. Explain the general reasoning behind the purchase of "Key Man" insurance.

12. What purposes are served by the purchase of various types of life insurance by an agribusiness?

13. Why should an agribusiness provide health and disability insurance for its employees?

14. What is meant by filing a claim?

15. What can any agribusiness do to reduce the possibility of having to file a claim?

INSTRUCTOR'S NOTES AND REFERENCES

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INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Insuring the Agribusiness

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES

1. Begin discussion of this problem area by asking about the details of some recent disaster that has been well publicized in the various news media. You may select something that occurred locally, statewide, or nationally, but do not be specific about the resulting damages.

2. Once students have exhausted most of the possible details about the tragedy, ask them how individuals and businesses are able to recover, particularly financially. Of concern with regard to recovery are such items as buildings, equipment, fixtures, records, inventory, downtime, lost sales and the possible loss of employees and management.

3. Ask students to explain, through class discussion, how the losses incurred as a result of the disaster, used in the example above, differ from losses incurred as a result of investing in the stock, bond, or commodity markets, or those losses due to gambling. Ask students to explain how the recovery process differs because of the losses listed here.

4. Ask students to discuss the losses incurred in these two situations in terms of risk and how they might distinguish between the two types of risk.

5. It should be clear, at least in part at this point, that insurance plays a major role in the recovery from a disaster. What may not be clear is how an insurance company can afford to withstand the financial demands. Therefore at this point it is suggested that the principle of "playing the odds" be introduced.

6. Continue class discussion by asking students to develop a list of issues of concern that agribusinesses will need to address in deciding:

   a. What to insure.
   b. How much insurance to have.
   c. What not to insure.
   d. What the agribusiness should and should not share with the insurance agent.
   e. How much to pay for insurance.
   f. What the agribusiness can do to reduce the need for and expense of insurance.

7. At this point it would be quite valuable to have an insurance agent visit the classroom and discuss the qualities that make an insurance agent a good agent from the agribusiness point of view. The agent should be well versed in business insurance and may also wish to address the issue concerning what an insurance agent is most concerned with when he or she discusses the insurance needs of an agribusiness with the owner/management of the agribusiness. In addition to issues with regard to the agent some discussion on insurance companies may also be beneficial.

8. Present the two primary categories of insurance, and the types of insurance under each category, that agribusinesses are most likely to carry.

9. When presenting each type of insurance stress what it is designed to cover. It is suggested that comments and discussion concerning the uniqueness of agribusiness also be addressed along with special policies designed to handle these unique situations.

10. Guest speakers that are knowledgeable about ways in which an agribusiness can reduce risks may also be used at this time. Such speakers might include someone from the fire department, police department, Occupational Safety and Health Administration, Environmental Protection Agency (Federal or State), insurance company, or agribusiness personnel responsible for safety/ maintenance programs. There are many private and public organizations actively involved in programs to reduce risks of all kinds that would be quite happy to address your classes.

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Insuring the Agribusiness

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES (Con't.)

INSTRUCTOR'S NOTES AND REFERENCES

11. Draw the problem area to a close with questions such as "In agribusiness today can all possible risks be removed? If yes, how? If no, why not and what can be done to reduce risks?" Finally, if an accident or damage does occur which involves an insurance company, what is the agribusiness's responsibility?

12. Other possible interest approaches might be:
    a. Have a claims adjuster visit the class and explain his duties, responsibilities, and the procedure he or she follows in settling a claim.
    b. Have an attorney in liable cases visit the class and discuss liability insurance and the issue of liability as it relates to various types of agribusinesses.

INSTRUCTIONAL RESOURCES

These resources are intended for use by teachers in planning and teaching the materials for this problem area and may be adapted to fit the teaching method(s) used.

INFORMATION SHEET #1 — Terms to be Defined

INFORMATION SHEET #2 — The Insurance Concept

INFORMATION SHEET #3 — Principles of Insurance

INFORMATION SHEET #4 — The Selection Process

INFORMATION SHEET #5 — Insurance Types

INFORMATION SHEET #6 — Insurance for the Employee

INFORMATION SHEET #7 — Personal Insurance

INFORMATION SHEET #8 — When Disaster Strikes

INFORMATION SHEET #1

Terms to be Defined

Actual value — the depreciated value of property.

Claim — request for payment by the insured to the insurer as a result of an occurrence causing financial hardship or loss.

Cottage industries — small entrepreneurial business generally conducted in a private home.

Deductible — a specified amount of loss the insured is willing to bear as a result of an occurrence after which the insurance will pay up to the limits of the policy.

Insurance — purchased protection against the risk of loss due to unforeseen occurrences.

Key man — person (or persons) working as employee(s) of a company whose temporary or permanent loss would cause the business considerable hardship.

Liability — financial responsibility to others.

"Playing the odds" — a determination based on statistics of the chances of a particular occurrence taking place under a specific set of circumstances.

Policy limits — the maximum specified amount a given insurance policy will pay a specified policy holder under a specific set of circumstances for a particular occurrence.

Premium — cost to the insured for a specific type of insurance and amount of coverage for a specific time.

Property — that which is owned by the business.

Pure risk — when persons are unwilling to suffer the results of an occurrence. Under normal circumstances such occurrence would be prevented if at all possible.

Replacement costs — the actual cost to replace property.

Self-insurance — the insurance by itself, generally undertaken by a large corporation or government agency with sufficient assets to cover claims against the corporation or agency.

80-20 Rule — generally most businesses will insure buildings, fixtures, and equipment at 80% of its replacement value leaving 20% of the replacement value to be covered by the business.

INFORMATION SHEET #2

The Insurance Concept

Assuming you owned an agribusiness, picture in your mind one or more chance occurrences at your agribusiness such as:

1. Earthquake.
2. Vandalism.
3. Windstorm (tornado).
4. Vehicle accident involving one of your trucks.
5. Fire.
6. Flood.
7. Sudden illness of your manager or a key employee which prevents the person from working for an extended period of time.
8. Your serious illness for an extended period of time.
9. Someone injured on the premises.
10. Theft.
11. Death or injury to a key person.

These are risks which are unplanned and which people are unwilling to accept, so they are called "pure risk" and are the reason for the existence of insurance. Any size agribusiness can be devastated by any of these occurrences, but small agribusinesses are particularly hard hit.

The original concept of insurance began when people realized that any of these occurrences could happen to anyone, but the questions remained, who and when? The solution was for each group of people to contribute, to a general fund, a small amount of money. When an occurrence of the nature of those listed above caused hardship for a group they could withdraw funds from the general fund to help recover from their losses without having to face the entire burden alone. Each group alone had only a small investment but the cumulative effects were great.

Out of this idea of individuals or small groups making small investments for the good of all grew the insurance agency.

INFORMATION SHEET #3

Principles of Insurance

Just as your age, sex, physical condition, and the medical history of yourself and your relatives influences an insurance company's calculations of your odds for health and life insurance, so too does the unique characteristics of an agribusiness effect insurance premiums. Factors such as the business location, the location in relation to the type of business conducted, products handled, services offered, and age and condition of property are some of the many factors considered.

Try to imagine the degree of risk associated with each of the following situations:

1. A grain elevator, feed mill, or fertilizer or chemical plant next to a set of railroad tracks that has been there for thirty years. The community it is located in had a population of 500 thirty years ago, but with the addition of a major manufacturer the population has swelled to over 20,000 today and has built homes on all sides of the agribusiness.
2. A small florist shop specializing in flower arrangements, greeting cards and gifts.

If you were asked to insure these two companies what factors would you be most concerned about in determining what types of insurance coverage each required and what the premiums for each would be?

Insurance companies have large quantities of data telling them statistically what the odds are of a particular occurrence happening in each of these cases and therefore what the premiums would be in order to properly cover the business and still permit the insurance company to make a profit.

Insurance costs money. In many cases, a considerable amount of money, but compared to the potential loss resulting from a pure risk occurrence it may become insignificant. It is important to remember that insurance is designed to protect against major losses and a way in which any agribusiness can reduce its insurance premium bill is to determine what losses it can afford to cover without insurance. Another way an agribusiness can reduce insurance expense is to purchase with deductibles or obtain policies which require the agribusiness to pay the first $100.00 to $1,000.00 of loss after which the insurance company will cover losses up to the limits of the policy. The higher the deductible the agribusiness is willing to bear the lower the insurance premium.

It is important to buy insurance with policy limits high enough to adequately protect against loss but not buy in excess of needs. A general rule of thumb when considering insurance on property is to figure the agribusiness can withstand 20% of a loss while the insurance policy should cover the remaining 80% of loss. Keep in mind however that this is a general rule and individual circumstances can alter this ratio considerably.

The news media often reports on lawsuits filed against companies seeking millions of dollars. It is important to keep two things in mind in such a situation:

1. The laws of the land permit anyone or group of individuals to sue any other person or group of people (an agribusiness) for any amount they wish.
2. The amount selected in the suit and what is finally settled upon may be quite different. It could be that no awards are made or that an even higher than requested award be granted.

Because there is no way to predetermine what actions will result in a lawsuit, it falls upon the owners of the agribusiness, trusted insurance agents, and perhaps an attorney to determine the best policy limits for a particular situations.

Insurance is not intended to make the insured a profit. In fact, there are very specific laws in many states which strictly forbid the insured from collecting more than once from one or more insurance companies for the same occurrences. Overinsuring property in hope of collecting a profit should a disaster occur is also illegal and usually prevented by insurance companies, because they can determine the true value of the loss. If you expect to receive adequate coverage you must be honest with them. Failure to be honest can result in cancellation of your policy when a claim is filed resulting in no payment.

Although price is very important when becoming insured, two other factors should also be of concern:

1. Can the insurance company provide all the services you require?
2. Is the insurance company familiar enough with your particular type of agribusiness and its unique characteristics to assist you in making the right decision?

These are important considerations which must be addressed. Good sources of information for answers to these questions are other businesses in the same community and your specific trade association.

Last but not least is the issue of your responsibility as a business owner/manager. You may be required by law to provide a safe place for employees and customers alike. Anything you can do to reduce risk means lower premiums for the agribusiness and a better place for anyone to be. There are many relatively inexpensive things you can do to reduce risks dramatically. Here is a partial list:

1. Regularly scheduled safety meetings.
2. Regularly scheduled and unscheduled safety inspections.
3. Safety and first aid training of *all* employees.
4. Fire alarms, smoke detection and fire protectio equipment.
5. Quality locks.
6. Compliance with OSHA and EPA standards.
7. An emergency plan with periodic drills.
8. A nonthreatening method of reporting safety violations and hazards.
9. Show concern for and make people aware of your concern for their safety and well-being at all times.
10. **FIX IT RIGHT AND FIX IT NOW!**

INFORMATION SHEET #4

The Selection Process

Selecting an insurance agent and insurance company can be equally if not more important to an agribusiness than selecting the proper coverage.

When selecting an agent it is important to select someone with whom you feel comfortable working with. It is also important that you select someone that has a good understanding of the unique characteristics of your agribusiness and with a sincere desire to provide the best possible insurance package.

The selection process is not unlike the selection process used in hiring new employees. Both parties must feel comfortable with the choice and must make an honest effort to present their case so that there is a minimum of misunderstanding. Any agent selected must be willing to spend the time necessary to meet the needs of your business.

Insurance agents generally represent a particular insurance company which offers a wide range of insurance plans or an independent agent that represents many insurance companies that specialize in particular types of insurance coverage. A good agent can almost be considered a member of your management team because of the tremendous amount of potential influence the agent may have.

Selection of an insurance company may be automatic if your agent only represents one company, but an independent agent or broker represents many companies. In this latter situation, selection of an insurance company should be a mutually agreed upon decision. Factors to consider when selecting an insurance company are:

1. Can the company meet the needs of your agribusiness?
2. What reputation does the company have for similar situations?
3. Is the insurance company sound financially?
4. Is the insurance company competitive in its pricing?

It is your agribusiness's money on the line so ask questions. Check with other businesses similar to yours. Check with your trade association. Check, through your public library, the ratings of various insurance companies by the A.M. Best Company, an insurance company rating service.

INFORMATION SHEET #5

Insurance Types

Two main categories make up the bulk of insurance. These categories are:

1. Property and Liability:
   a. Property — insurance for buildings and other property.
   b. Liability — insurance protection for injury claims against the agribusiness and protection for claims of injury or loss of property from negligence on the part of the agribusiness.
2. Life and Health.

Before deciding what types of and how much property and liability insurance to get, the agribusiness owner/manager must consider:

1. Risks associated with property:
   a. First take a physical inventory of all property of the business. This inventory will include buildings, furnishings, equipment, and machinery. Determine actual value and replacement costs.
   b. Consider all the different types of occurences that could cause damage or loss of this property, from simple theft to a major disaster.
2. Risks associated with liability:
   a. Based on your particular type of agribusiness, for what types of damage to others might you be held financially accountable?
   b. Consider all the different reasons why you might be sued.

There are a number of different types of property and liability insurance. These include:

1. Business interruption — insurance that can help fill the gap in lost income if your business is destroyed and if it will take some time before you can rebuild or relocate.

2. Marine and inland marine — insurance designed for ships and their cargoes. Inland marine covers goods in transit on trains, trucks, or other methods of product movement. Some special items can also be covered here such as comptuer hardware and software.

3. Motor vehicle insurance — provides coverage for company-owned vehicles. If many vehicles are owned, fleet prices may be available.

4. Product and professional liability — provide protection against claims of injury resulting from use or consumption of your product. This is an area of ever increasing costs to all businesses. Professional liability provides protection against claims as a result of providing a service.

5. Property and liability package policies — offered as a way to cover all risks associated with a business. However, because of the uniqueness of many agribusinesses, these policies should be examined closely to be sure that your agribusiness needs are covered. If you find areas missing from a package policy, have additional policies or riders added to the package policy to cover your needs. Other types of property and liability insurance are designed to protect businesses with unique circumstances such as aviation insurance, accounts receivable credit insurance, and crop insurance.

INFORMATION SHEET #7

Personal Insurance

Generally, as an individual owner of a business, the individual has invested personal assets and borrowed capital to get started and keep the business running. Should the owner die the debts incurred by the owner fall back upon the family. Depending on the circumstances, this could be a sizable burden. In order to reduce or eliminate this burden many owners will purchase large amounts of life insurance through the company to handle debts upon their death.

Similarly, partners may purchase life insurance on one another to settle debts and buy out a partner's share of the business. A corporation may also purchase life insurance on its owners if it is a closely held corporation. This would lend a degree of stability to the corporation upon the death of one of its owners.

Life insurance comes in two basic formats, Term and Whole Life.

1. Term is cheaper than whole life and as the name implies it is purchased for a specific term or length of time at a fixed rate based on the age and sometimes health of the individual. As the policy holder gets older the premiums go higher because the policy holder is nearer death. At the end of the term the policy may be automatically renewable or require a physical exam before considering renewal. Term insurance does not have a cash surrender value but the policy holder can buy a great deal more insurance for the same or less money compared to whole life.

2. Whole life, as the name implies, is generally purchased for the entire life of the policyholder. A flat rate premium is guaranteed regardless of changes in health and age. The policyholder continues to pay premiums until death or when the policy is paid up. As the policyholder pays premiums the policy builds a cash value which may be borrowed or the policy's cash value can be used as collateral on a loan. Should the policyholder die before the loan against the policy is repaid, the unpaid balance will be subtracted from the payment by the insurance company.

The type of life insurance selected should be based on the financial needs and goals of the individuals. Some may choose term insurance and use the savings realized in reduced premiums to invest in higher profit ventures. Others may wish to have the security of whole life insurance. Insurance companies frequently change policies to reflect competitive economic conditions. Therefore it will pay to shop for the best buy.

Other types of insurance which the individual needs to consider are credit life, and health and disability insurance.

1. Credit life is a life insurance policy required by a lender when money is borrowed. This type of insurance will pay to the lender the balance of a loan upon the death of the borrower. The lender may require the borrower to buy the life insurance or may buy it for the borrower. Either way the borrower pays for the insurance as part of the cost of borrowing money. If the lender buys the insurance it is usually cheaper because the lender will buy at a group rate.

2. Health and disability insurance is just as important for owners and management as it is for employees. Depending on the benefit package available to employees, owners and management may be able to participate in the same plan or they may have to purchase their own insurance individually. The employee benefit package will generally be a group package which will be much less expensive than an individual policy.

Business insurance for a business in the home is the last category of personal insurance. If you operate a business out of your home, say a business that is just getting started, chances are very good your homeowners policy will *not* cover business-associated claims. A separate policy will have to be written to cover that portion of the home used for business and the activities associated with the business.

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INFORMATION SHEET #8

When Disaster Strikes

If a disaster does happen (and it is unusual for a business to operate and not have at least some minor problems) your agent must be contacted immediately. The sooner you contact your agent the more details you will be able to relate accurately. You may also choose to follow up a telephone call with a written copy of the incident, keeping a copy for your records.

As procedures vary among companies as to how to file a claim, it is important to become familiar with the procedures before it is necessary to file. Some guidelines to follow are:

1. For property insurance, have a complete record of all property in a safe place. Be sure other important individuals are aware of the policies and their locations.
2. Depending on the location of the claim you may be advised to notify the police immediately in addition to your insurance agent.
3. Should structural damage occur be sure to take care that no additional damage occurs. Board up windows, cover unprotected areas, and block off areas to access by anyone but those authorized to enter a dangerous area.
4. In case of an accident which may result in a liability issue, be sure to notify your agent promptly.
5. Should personal injury occur at the business do not admit fault. See that the individual gets prompt medical assistance and notify your agent. Failure to follow proper procedures as specified in your policy could result in cancellation of the policy.

STUDENT ACTIVITIES

STUDENT WORKSHEET #1 — Insurance Policies

STUDENT WORKSHEET #2 — Crossword Puzzle

For additional activities, teachers may refer to the "Suggested Teaching Activities and Procedures" section in the Instructor's Guide.

STUDENT WORKSHEET #1

Insurance Policies

Divide class into groups of two or three students and assign each group the responsibility of acquiring a sample insurance policy for a specific type of insurance for an agribusiness agreed upon.

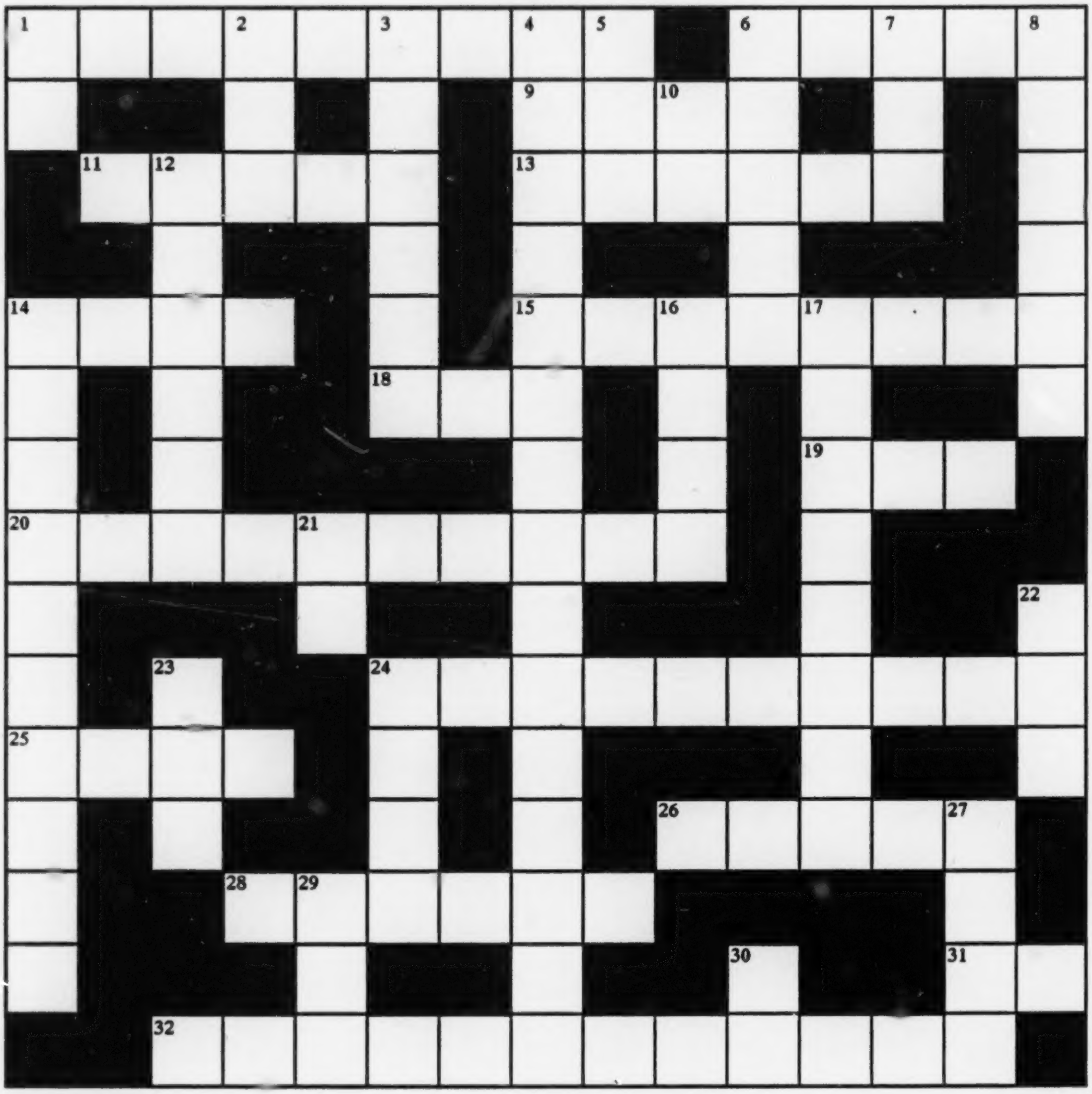
Have each student prepare a brief paper that answers the following questions:

1. What type of insurance coverage does this policy address?
2. What are the limits of the coverage?
3. How long does the policy remain in effect?
4. Is the policy renewable?
5. Does the policy have a cash value? If so, how is it determined?
6. What does the insurer agree to in the policy?
7. What must the insurer do to keep the policy in force?
8. What promises are there for cancellation of the policy?
9. What promises are there for reinstatement of the policy?
10. Does the policy have a grace period?
11. Who must sign the policy?
12. How is the beneficiary designated?
13. Given a specific set of circumstances what would be the premiums for this policy?

Most, but not all, of these questions will apply to every type of insurance. Each group should make a brief oral presentation of their paper to the class (3 to 5 minutes) responding to each of the questions above that is applicable to the type of insurance they were assigned.

STUDENT WORKSHEET #2

Crossword Puzzle



ACROSS

1. For protection against disaster.
6. File in case of accident.
9. National safety association.
11. Represents insurance company.
13. Percent agribusiness will cover.
14. Type of insurance.
15. Aerial applicators insurance.
18. Record of progress.
19. Common elevator pest.
20. Employee insurance that provides an income.
24. Reduces premiums.
25. Insurance purchased by partners.
26. A common refrain.
28. Percent insurance will cover.
31. To perform an action.
32. Maximum allowed.

DOWN

1. Opposite of out.
2. To take advantage.
3. Can insure for this value.
4. Business operated in the home.
5. From 90° to 270° on a compass.
6. Popular tall flower.
7. One, no matter which, of more than two.
8. Insurance to cover ships.
10. Pronoun.
12. Generally pay less than individuals.
14. Insurance purchased with a loan.
16. Not nice.
17. Less expensive life insurance.
21. To exist.
22. Insurance for V.I.P.'s in agribusiness.
23. Popular organization in agriculture.
24. Dinner bell sound.
27. Insurance companies play these.
29. Not feeling well.
30. Before noon

STUDENT WORKSHEET #2 — Key

Crossword Puzzle

1 I	N	S	2 U	R	3 A	N	4 C	5 E	■	6 C	L	7 A	I	8 M
N	■	■	S	■	C	■	9 O	S	10 H	A	■	N	■	A
■	11 A	12 G	E	N	T	■	13 T	W	E	N	T	Y	■	R
■	■	R	■	■	U	■	T	■	■	N	■	■	■	I
14 C	R	O	P	■	A	■	15 A	V	16 I	A	17 T	I	O	N
R	■	U	■	■	18 L	O	G	■	C	■	E	■	■	E
E	■	P	■	■	■	■	E	■	K	■	19 R	A	T	■
20 D	I	S	A	21 B	I	L	I	T	Y	■	M	■	■	■
I	■	■	■	E	■	■	N	■	■	■	L	■	■	22 K
T	■	23 F	■	■	24 D	E	D	U	C	T	I	B	L	E
25 L	I	F	E	■	I	■	U	■	■	■	F	■	■	Y
I	■	A	■	■	N	■	S	■	26 E	I	E	I	27 O	■
F	■	■	28 E	29 I	G	H	T	Y	■	■	■	■	D	■
E	■	■	■	L	■	■	R	■	■	30 A	■	■	31 D	O
■	■	32 P	O	L	I	C	Y	L	I	M	I	T	S	■

ACROSS

1. For protection against disaster.
6. File in case of accident.
9. National safety association.
11. Represents insurance company.
13. Percent agribusiness will cover.
14. Type of insurance.
15. Aerial applicators insurance.
18. Record of progress.
19. Common elevator pest.
20. Employee insurance that provides an income.
24. Reduces premiums.
25. Insurance purchased by partners.
26. A common refrain.
28. Percent insurance will cover.
31. To perform an action.
32. Maximum allowed.

DOWN

1. Opposite of out.
2. To take advantage.
3. Can insure for this value.
4. Business operated in the home.
5. From 90° to 270° on a compass.
6. Popular tall flower.
7. One, no matter which, of more than two.
8. Insurance to cover ships.
10. Pronoun.
12. Generally pay less than individuals.
14. Insurance purchased with a loan.
16. Not nice.
17. Less expensive life insurance.
21. To exist.
22. Insurance for V.I.P.'s in agribusiness.
23. Popular organization in agriculture.
24. Dinner bell sound.
27. Insurance companies play these.
29. Not feeling well.
30. Before noon

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Planning and Organizing the Agribusiness

RELATED PROBLEM AREAS:

1. Managing Entrepreneurship Opportunities in Agriculture

2. Financing the Agribusiness

3. Operating the Agribusiness

PREREQUISITE PROBLEM AREA(S):

1. Understanding Basic Business Organization (Central Core Cluster)

LEVEL: Preparatory

OCCUPATIONAL TASKS ADDRESSED:

Agricultural Business and Management Cluster

Duty H: Managing the Business

1. Determine labor needs
2. Evaluate employee performance
3. Evaluate agribusiness productivity
4. Supervise agriculture workers

Horticulture Cluster

Duty Q: Managing the Business

1. Plan work schedules
2. Determine labor needs
3. Evaluate employee performance
4. Prepare reports
5. Develop business agreements

STATE GOALS FOR LEARNING

In planning the instruction for this problem area, teachers can promote the development of several student learning objectives which are related to the State Goals for Learning in Language Arts and Social Sciences. These objectives are listed on the Learning Assessment Plan forms included on the following page(s). Those learning objectives marked with an asterisk (*) are taken from the sample lists provided by the Illinois State Board of Education.

Illinois Agricultural Core Curriculum

Agricultural Education 124 Mumford Hall 1301 W. Gregory Drive University of Illinois Urbana, IL 61801

Director: Dale A. Law, Ed.D.
Principal Investigator: Jerry D. Pepple, Ed.D.
Research Assistant: James K. Shinn

Submission Date ____________

☐ Original submission ☐ Revision

Page ____ of ____

I. LEARNING AREA *(check one)*

☒ Language Arts
☐ Mathematics
☐ Sciences
☐ Fine Arts
☐ Social Sciences
☐ Physical Development/Health

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)

COUNTY	DISTRICT	ESC

District Name

City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to listen critically and analytically.

Contact Person: ____________

Title: ____________

Phone: (   )

III. LEARNING OBJECTIVES

By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:

III. LEARNING OBJECTIVES	IV. ASSESSMENT A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	V. EXPECTATIONS Percent of Students Expected to Achieve Objective
*1. Develop a sequence of ideas from spoken messages.					
*2. Generate a plan using differing perspectives and points of view.					

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date ____________
☐ Original submission ☐ Revision
Page ____ of ____

(Affix label or complete district information.)
COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐
District Name
City

I. LEARNING AREA *(check one)*
☐ Language Arts
☐ Mathematics
☐ Sciences
☐ Fine Arts
☒ Social Sciences
☐ Physical Development/Health

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to apply the skills and knowledge gained in the social sciences to decision making in life situations.

Contact Person: ____________
Title: ____________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Evaluate the costs and benefits of a particular course of action.					
*2. Distinguish between rights and responsibilities of employers and workers in the work place.					
*3. Analyze the relationship between individual and societal value systems.					
*4. Analyze the management of human and material resources.					

ISBE 41-78 (1/86)

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Planning and Organizing the Agribusiness

STUDENT LEARNING OBJECTIVES

Upon completion of their study of this problem area, students will be able to:

1. Demonstrate their understanding of the planning concept as the basic tool for giving direction to an agribusiness, by developing a basic plan for a simulated agribusiness by using the six step process.
2. List the levels of a business matrix and explain, using a matrix, how planning requirements change at various levels of management.
3. Discriminate the difference among policies, procedures, and practices by active participation in a class activity to develop three policies for business and/or practices of employees in relation to those policies; and write a critique of the differences between the intended results of the policies and what actually happened.
4. Demonstrate the importance of setting objectives by developing a list, in class, of personal versus business objectives for accomplishing a specific goal.
5. Generate a basic plan to be handed in, for a simulated agribusiness using the six steps in the planning process on the forms provided.
6. Demonstrate understanding of organizing by generating a basic organizational plan, in writing, for the same simulated agribusiness using the five steps of organizing on the forms provided.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Planning and Organizing the Agribusiness

PROBLEMS AND QUESTIONS FOR STUDY

1. What is planning?
2. Why is planning so necessary?
3. What would be some of the expected outcomes of a good plan?
4. What are the levels of management in an agribusiness?
5. How do tasks at the various levels of management differ?
6. Based on the tasks at each level of management how would plans differ?
7. What are policies, procedures, and practices?
8. What would be the expected outcomes of a breakdown in communication between policy makers and production employees?
9. What should be included in well-stated objectives?
10. In which areas of an agribusiness are objectives most likely to be found?
11. Name the six steps to be followed in developing a plan for an agribusiness.
12. What are some sources of assistance available for developing a plan?
13. What is meant by organizing a business?
14. Why is organizing the first function of management following planning?
15. What does organizing involve?
16. Why is organizing said to be more than just a formal plan?
17. What is an organizational plan designed to do?
18. What outcomes might be expected as a result of a good organizational plan?

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Planning and Organizing the Agribusiness

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES

Many of the concepts presented in this problem area will be very new to your students. These concepts can become more understandable and meaningful if they are related to student experiences in the school and community environment.

1. It is strongly recommended that an agribusiness leader in the local community be asked to give a presentation to the students on the topic: ***Agribusiness Image and Civic Responsibility to the Local Community.*** It is also suggested that these issues be discussed in relation to their effects on planning and organizing the agribusiness.

2. Begin instruction through open discussion of the following questions:
   a. Do you make plans?
   b. Why do you make plans?
   c. What kinds of plans do you make?
   d. Are some of your plans long range or short range? How do they differ in what is included?

3. Lead a class discussion on plans the students have made for personal activities. Guide the discussion toward a comparison of planning in an agribusiness which includes the following:
   a. Why is planning necessary in an agribusiness?
   b. What exactly is planning?
   c. What areas of an agribusiness require planning?
   d. What might some expected outcomes of good planning be?
   e. What outcomes may result due to poor planning?

4. Using the example of dating, discuss the expected outcomes of good and poor planning. Draw discussion to a close by making a comparison between planning for a date and planning for an agribusiness.

5. Using the basic principle of planning, plans become more specific and shorter term as we move from top management, to middle management, to production employee. Develop a matrix to demonstrate this principle.
   a. Draw a matrix of columns and rows 4 x 5 or use the transparency master included.
   b. Have students label columns for the levels of management from top management to production employee.
   c. A brief discussion on the tasks to perform at each level of management will benefit here.
   d. Label rows as to the nature or format of plans.
   e. Guide students in filling in the cells by listing characteristics of plans at each level of management.

6. Relate content of matrix to students' own personal work experiences in FFA, and/or SAE projects.

7. Using the student handbook or other source of student conduct for your school, have students separate out what they believe are policies, procedures, and practices of the school. An open discussion of the differences would be beneficial here.

8. Have students develop a comparison list between the policies, procedures, and practices of the school and a local agribusiness through class discussion.

9. Divide the class into two groups. Label one group agribusiness managers or school administrators and the other group production employees or students. Give the management/administrative group about ten minutes to write down three general policies about employee/student conduct as it relates to agribusiness/school image and an upcoming event such as a company open house or school sponsored dance. Ask the employee/student group to record their practice in response to the policies. The employee/student group should be given about ten minutes to respond. Watch for conflicts in the thinking as stated by the two groups. Point out the conflicts and ask each student to write a brief paper on why these conflicts erupted and how they could be resolved.

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Planning and Organizing the Agribusiness

INSTRUCTOR'S NOTES AND REFERENCES

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES (Con't.)

10. Discuss what objectives are and why they are the first step in the planning process.

11. Ask students what characteristics are necessary for good objectives.

12. Using student input, develop a list of objectives that would be typical for a local agribusiness. Once again a comparison of your school and an agribusiness might be helpful.

13. Present a brief overview of the six steps in the planning process with a brief discussion by the class on the importance of each.

14. Have each student develop a general plan for a specific type of agribusiness using the six step process on the forms provided.

15. Begin discussion of organization by asking students to list and explain the duties and responsibilities of the FFA officials, Student Government Officers, players at specific positions on an athletic team, or members of the school band.

16. Draw a comparison between these school-related organizational plans and those of an agribusiness, being as specific as possible in the points of comparison.

17. Using the same agribusiness for which the students developed a general plan in item 14 above, have the students develop an organizational plan in writing on the forms provided.

18. Select two of the better and poorer general and organizational plans, keeping authors anonymous, and ask the class to critique the examples as to their possible outcomes.

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Planning and Organizing the Agribusiness

REFERENCES **INSTRUCTOR'S NOTES AND REFERENCES**

1. *Doin' Business: Users Handbook.* Downing and Hirsh. (1980). The Institute for Constructive Capitalism, The University of Texas at Austin, 2815 San Gabriel, Austin, TX 78705. (512) 478-4081.

2. *Exploring Agribusiness.* (1980). Ervell, P.R. Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

3. *An Introduction to Agribusiness Management.* (1979). Wills, W.J. Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

4. *Principles of Agribusiness Management.* (1986). Beirlein, J.G., Schneiberger, K.C., Osborn, D.D. Prentice Hall, Englewood Cliffs, NJ 07623.

*5. *Agribusiness Management.* (1987). Downy, W.D., Erickson, S.P. McGraw-Hill Publishing Company, 1221 Avenue of the Americas, New York, NY 10124-0025.

*Indicates highly recommended reference

INSTRUCTIONAL RESOURCES

These resources are intended for use by teachers in planning and teaching the materials for this problem area and may be adapted to fit the teaching method(s) used.

INFORMATION SHEET #1 — Terms to be Defined

INFORMATION SHEET #2 — The Levels and Nature of Planning in Business Matrix

INFORMATION SHEET #3 — Criteria for Well-Stated Objectives

INFORMATION SHEET #4 — Areas of Agribusiness where Objectives Will Be Found

INFORMATION SHEET #5 — The Six Steps in the Planning Process

INFORMATION SHEET #6 — What is Involved in Organizing

TRANSPARENCY MASTER #1 — The Levels and Nature of Planning in the Agribusiness

TRANSPARENCY MASTER #2 — Developing an Agribusiness Plan

TRANSPARENCY MASTER #3 — Developing an Organizational Plan

It is also recommended that the following individuals and/or organizations be contacted for additional assistance and support: Community Resource Development Advisor at your County Cooperative Extension Service office or your state office; S.C.O.R.E, your local chapter of the Service Core of Retired Executives; The Small Business Administration; The Local Chapter of the Chamber of Commerce; and Professional Trade Associations for the various types of agribusinesses in your community.

INFORMATION SHEET #1

Terms to be Defined

Business — an organization created to coordinate and manage private resources to generate a profit.

Employee relations — what is expected of employees and what rewards they will receive.

Investor relations and returns — what portion of business earnings should go to investors.

Market standing — the position a business holds in relation to its competitors.

Objective — statements developed by top management, boards of directors, and chief executives to define what they believe to be the organization's mission.

Organizing — the grouping of activities and fitting together of people in the best possible relationships to get work done effectively and economically and to help achieve the objectives and goals of the enterprise.

Physical resources — equipment, tools, etc., needed to operate business.

Planning — forward thinking about courses of action based upon full understanding of all factors involved and directed by specific objectives.

Policies — general guidelines for handling various circumstances that are expected to arise frequently.

Practices — represent what is actually done in the agribusiness.

Procedures — a step by step guide to a specific activity or function.

Production employees — those individuals or groups involved in the direct performance of daily tasks to produce a product or provide a service for which the agribusiness was established.

Profitability — what kinds and amounts of profit are possible.

Public responsibility — obligation and accountability on the part of a business to its community.

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INFORMATION SHEET #2

The Levels and Nature of Planning in Business Matrix

Policy Level	Middle Management	Supervisor Level	Production Employee
very flexible	somewhat flexible	discretionary changes	inflexible
long range	intermediate range	short term	immediate
written analyses	written, reports	outlined	unwritten
complex, detailed	less detail, outlined	highlighted	simple
broad	general	somewhat specific	very specific

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INFORMATION SHEET #3

Criteria for Well-Stated Objectives

Well-stated objectives should:

1. Record the direction the agribusiness should take.
2. Provide guides for the goals and results of each unit or person.
3. Allow appraisal of the results contributed by each unit or person.
4. Contribute to a successful overall organizational performance.
5. Indicate the philosophy and desired image of the organization.

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INFORMATION SHEET #4

Areas of Agribusiness where Objectives Will Be Found

Objectives are usually found in the following business areas:

1. Market standing (position compared with competitors).
2. Growth and development (how much and how fast should growth be?).
3. Profitability (what kinds and amounts of profit are feasible?).
4. Employee relations and performance (what rewards and share of income should go to employees, and what is expected of them?).
5. Investor relations and returns (what portion of earnings should go to investors?).
6. Public responsibility and relationships (what kind of business citizen does the company want to be?).
7. Physical resources (what plant equipment, tools, etc., are needed?).
8. Products and innovation (what emphasis will be placed on new products and research?).

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INFORMATION SHEET #5

The Six Steps in the Planning Process

The Planning Process
There are six steps in the planning process. These are:

1. *Gathering facts* and information that have a bearing on the situation.
2. *Analyzing* what the situation is and what problems are involved.
3. *Forecasting* future developments.
4. *Setting goals,* the bench marks for achieving objectives.
5. *Developing alternative* courses of action and selecting those that are most suitable.
6. *Developing a means of evaluating progress,* and readjusting one's sights as the planning process moves along.

Step 1: Gathering facts. Gathering of facts and information has been dubbed the first step of the planning process, even though information gathering is a constant, recurring part of the planning process. Its place as a first step is easily justified, since adequate information must be available to indicate the suspected problem or opportunity present.

Fact gathering is subdivided into two parts: gathering sufficient information to identify the need for a plan in the first place, and systematic gathering of specific facts needed to make the plan work once it has been decided upon.

Because of the difficulty in gathering facts, some managers tend to slide by this step of the planning process and resort to the "seat of the pants" philosophy, which reduces the likelihood of success. On the other hand, one should not become so engrossed in fact gathering that inaction results.

Step 2: Analyzing the facts. The groundwork for developing a sound plan is laid in the process of analyzing the facts. This process answers such questions as "Where are we?" and "How did we get here?" It helps pinpoint existing problems and opportunities, and provides the framework upon which to base successful decisions.

Step 3: Forecasting change. The forecasting of change is the ultimate test of good planning. It has been truly said that the ability to determine what the future holds is the highest form of management skill.

As managers ascend the organizational ladder, the demands on their abilities steadily increase. The broader, the more complex, the more long-range a plan is, the more difficult it is to foresee results accurately.

As with all of the steps of planning, forecasting is interrelated with all the other steps. Actually, it is simply the logical extension of analyses into a future time setting. Many say, "No one can predict the future in our business." While no one can be expected to predict accurately all future developments, this is hardly a good reason for not attempting to predict the future at all.

Many failures in prediction result from sloppy, ambiguous, generalized thinking. Forecasting change is not a guessing game; it is based on a hard, disciplined, tough approach to planning.

Step 4: Setting goals and results. Many management specialists consider goal setting to be the first step in the planning process. In a way they are correct, but in the present division of the planning steps, it seems that the formulation of information is part of goal setting.

All these processes are going on continuously in the funnel of planning. Goals cannot be set in a vacuum, but must be related to the attainable. Therefore, they must be formed as a consequence of the gathering of, and analysis of, information and facts. They should be aimed toward organizational objectives.

Step 5: Developing alternatives. After goals have been set, *alternative courses* of action must be developed; that is, agribusiness managers must explore the different ways of getting wherever they want to go.

Here again the relationship between *goals* and *results* can be seen. The *results* achieved depend upon the alternative activities selected to meet the *goals.* Alternatives must be weighed, evaluated, and tested in the light of the unique agribusiness's resources. Imagination is crucial, since new ways and/or new paths can blaze the route to success.

The uniqueness of the alternative developed in this step must be stressed. For example, corn might be shipped to a distant city by truck when rail might have been the best and quickest way to get it there. But if one cannot afford to send it that way, or if there is no railroad available, a truck may well be the best alternative.

Step 6: Evaluating Progress. Surveillance and checking of progress have been found by management specialists to be one of the highest priorities. *Evaluation* shows whether the plan is on course, and allows both the analysis of *new* information and the discovery of *new* opportunities.

Evaluation cannot be left to chance. It must be incorporated into the planning process as one of the most important steps, since a plan is only good as long as the situation remains unchanged. For this reason, the plan must be evaluated when it is formed into a program of specific activities, and once it is underway.

From evaluation one can tell whether goals have been achieved, whether results matched goals, and where the results fell short or overshot goals. It also points up weaknesses in plans and programs so that those portions that are ineffective can be changed. In a fast-changing world, planning is essential to management success.

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INFORMATION SHEET #6

What is Involved in Organizing

Organizing involves:

1. Setting up structure.
2. Determining jobs to be done.
3. Selecting, allocating and training personnel.
4. Defining lines of activity.
5. Establishing relationships within the organization and then staffing them.

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TRANSPARENCY MASTER #1

The Levels and Nature of Planning in the Agribusiness

Levels of Management

Nature of Plans

TRANSPARENCY MASTER #2

Developing an Agribusiness Plan

Select a specific type of Agribusiness and using the form provided develop a general plan which this Agribusiness might prepare to become an established, profitable part of your community.

Agribusiness Type:

Step 1: Gathering facts (list the kinds of facts you feel are necessary to have before you begin the business).

Step 2: Analyzing the facts (explain how this information might be used to begin the business).

Step 3: Forecasting change (agribusinesses are generally started with the idea that they will go on forever. What changes would you see this business facing in the months and years to come as it grows and expands?).

Step 4: Setting goals and results (list the things you want this agribusiness to accomplish the first year, first five years, and for the life of the agribusiness).

Step 5: Developing alternatives (most things do not go as planned and results are not always achieved. Therefore, you must have some secondary plans ready. List two possible problems your agribusiness might anticipate and recommend appropriate changes).

Step 6: Evaluating progress (how will you know if you are going to be successful with your plan once your agribusiness is started? List at least five ways in which you can check the results of everyone's efforts towards your stated goals).

TRANSPARENCY MASTER #3

Developing an Organizational Plan

Using the same Agribusiness you developed a general overall plan for, you are to develop an organizational plan using the format provided.

Step 1: Setting up structure (how will this agribusiness be managed from top to bottom? Can one person perform all management functions? If not, in which areas will key people be placed?).

Step 2: Determining jobs to be done (list specific jobs that will need to be done at every level to produce and sell or provide your product or service).

Step 3: Selecting, allocating, and training personnel (explain how you decide who to hire. List the number of people you will need in each area of the agribusiness. Explain briefly the type of training that will be needed to be successful in each new position).

Step 4: Define lines of activity (draw a chart showing how raw materials or products needed to produce a product or provide a service move through the business from your supplier to your customer).

Step 5: Establishing relationships within the organization and then staffing them (list the responsibilities of key people from step 1. Explain the safeguards you would use to see that these key people would carry out their responsibilities).

STUDENT ACTIVITIES

STUDENT WORKSHEET #1 — Developing an Agribusiness Plan

STUDENT WORKSHEET #2 — Top Management/School Administrator Policy

STUDENT WORKSHEET #3 — Production Employee/Student Practice

STUDENT WORKSHEET #4 — Developing an Agribusiness Organizational Plan

For additional activities, teachers may refer to the "Suggested Teaching Activities and Procedures" section in the Instructors Guide.

STUDENT WORKSHEET #1

Developing an Agribusiness Plan

Select a specific type of Agribusiness and using the form provided develop a general plan which this Agribusiness might prepare to become an established profitable part of your community.

Agribusiness Type:

Step 1: Gathering facts (list the kinds of facts you feel are necessary to have before you begin the business).

Step 2: Analyzing the facts (explain how this information might be used to begin the business).

Step 3: Forecasting change (agribusinesses are generally started with the idea that they will go on forever. What changes would you see this business facing in the months and years to come as it grows and expands?).

Step 4: Setting goals and results (list the things you want this agribusiness to accomplish the first year, first five years and for the life of the agribusiness).

Step 5: Developing alternatives (most things do not go as planned and results are not always achieved. Therefore, you must have some secondary plans ready. List two possible problems your agribusiness might anticipate and recommend appropriate changes).

Step 6: Evaluating progress (how will you know if you are going to be successful with your plan once your agribusiness is started? List at least five ways in which you can check the results of everyone's efforts towards your stated goals).

STUDENT WORKSHEET #2

Top Management/School Administrator Policy

Your group is to develop three policies of a general nature that are designed to control employee/student behavior in a given situation. The following policies will be followed by the employee/student to reflect the proper image of the Agribusiness/school.

Policy 1:

Policy 2:

Policy 3:

STUDENT WORKSHEET #3

Production Employee/Student Practice

Using the policies provided by the Top Management/School Administrator develop a list of appropriate activities your group would engage in that would protect the image of your employer/school. Remember that such practices could very well carry beyond the business/school setting.

Practice 1:

Practice 2:

Practice 3:

STUDENT WORKSHEET #4

Developing an Agribusiness Organizational Plan

Using the same Agribusiness you developed a general overall plan for you are to develop an organizational plan using the format provided.

Step 1: Setting up structure (how will this agribusiness be managed from top to bottom? Can one person perform all management functions? If not, in which areas will key people be placed?).

Step 2: Determining jobs to be done (list specific jobs that will need to be done at every level to produce and sell or provide your product or service).

Step 3: Selecting, allocating, and training personnel (explain how you decide who to hire. List the number of people you will need in each area of the agribusiness. Explain briefly the type of training that will be needed to be successful in each new position.

Step 4: Define lines of activity (draw a chart showing how raw materials or products needed to produce a product or provide a service move through the business from your supplier to your customer).

Step 5: Establishing relationships within the organization and then staffing them (list the responsibilities of key people from step 1. Explain the safeguards you would use to see that these key people would carry out their responsibilities).

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Advertising and Selling Agricultural Products and Services

RELATED PROBLEM AREAS:

1. Marketing Agricultural Products and Services (Central Core Cluster)
2. Recognizing the Role of Agriculture in Society (Central Core Cluster)
3. Developing Communication Skills in Agriculture (Central Core Cluster)
4. Developing Human Relation Skills in Agriculture (Central Core Cluster)
5. Identifying and Practicing Ethics in Agriculture (Central Core Cluster)

PREREQUISITE PROBLEM AREA(S): None

LEVEL: Preparatory

OCCUPATIONAL TASKS ADDRESSED:

Agricultural Business and Management Cluster

Duty B: Performing Sales

1. Determine customer needs
2. Locate merchandise
3. Compute sales tax
4. Complete sales slip
5. Inform customers of warranty and guarantee specifications
6. Close sale
7. Conduct sale
8. Complete business form
9. Communicate orally with clients

Duty C: Performing Sales-Related Duties

1. Open store or department
2. Process debit card sales transaction
3. Process charge card sales transaction
4. Package customer purchases
5. Arrange delivery of merchandise
6. Process customer complaints
7. Close out cash register
8. Close store or department
9. Process customer refund on sale
10. Process cash sales transaction
11. Order supplies and stock
12. Process incoming order
13. Return unuseable merchandise
14. Code and date merchandise

15. Label and price merchandise
16. Update prices on merchandise
17. Stock merchandise displays
18. Stock merchandise in storage area
19. Rotate supplies and stock
20. Greet and meet people

Duty E: Performing Promotional Activities

1. Maintain customer file system
2. Plan territory management
3. Analyze and interpret market information
4. Prepare advertisements
5. Conduct sales promotional meetings
6. Identify potential buyers
7. Provide technical assistance to customers
8. Plan a sales promotional meeting
9. Build merchandise displays
10. Calculate customer discount

Duty F: Financing the Agribusiness

1. Prepare cash flow projections
2. Develop credit plan
3. Prepare tax statements
4. Calculate insurance needs
5. Prepare depreciation schedule
6. Prepare bank statements
7. Prepare cash flow statement
8. Record accounts payable in computerized bookkeeping system
9. Record accounts receivable in computerized bookkeeping system
10. Balance charge receipts and cash tickets.

Duty G: Performing General Office Work

1. Establish filing system
2. Establish file index
3. File materials, such as receipts, letters, documents, specifications, and orders
4. Write field reports
5. Type reports
6. Process incoming mail
7. Process outgoing mail
8. Maintain mailing lists
9. Schedule appointments and meetings
10. Process incoming telephone calls
11. Process outgoing telephone calls
12. Duplicate materials
13. Clean work area
14. Make minor office equipment repairs

Duty H: Managing the Business

1. Conduct periodic inspection of merchandise
2. Conduct inventory of merchandise
3. Maintain inventory records
4. Plan work schedule

STATE GOALS FOR LEARNING:

In planning the instruction for this problem area, teachers can promote the development of several student learning objectives which are related to the State Goals for Learning in Mathematics, Language Arts, and Social Sciences. These objectives are listed on the Learning Assessment Plan forms included on the following page(s). Those learning objectives marked with an asterisk (*) are taken from the sample lists provided by the Illinois State Board of Education.

CORE

Illinois Agricultural Core Curriculum
Agricultural Education 124 Mumford Hall 1301 W. Gregory Drive University of Illinois Urbana, IL 61801

Director: Dale A. Law, Ed.D.
Principal Investigator: Jerry D. Pepple, Ed.D.
Research Assistant: James K. Shinn

Submission Date ____________________
☐ Original submission ☐ Revision
Page ____ of ____

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)

COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐

District Name

City

I. LEARNING AREA *(check one)*

☐ Language Arts ☐ Fine Arts
☐ Mathematics ☒ Social Sciences
☐ Sciences ☐ Physical Development/Health

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to apply the skills and knowledge gained in the social sciences to decision making in life situations.

Contact Person: ____________________
Title: ____________________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Apply the principles of comparative pricing to real-life situations.					
*2. Apply a rational decision-making process based on goals, values and needs to selected consumer social problems.					
*3. Analyze the types of information sources needed to make effective consumer decisions.					
*4. Evaluate the costs and benefits of a particular course of action.					
5. List three reasons why advertising is a necessary part of any business in a free enterprise system.					
6. Explain how advertising benefits consumers in a free enterprise system by listing three examples of benefits they have received, on paper, including the name of the product or service, what the form of media was, and how they responded to the advertisement.					

ISBE 41-78

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date ____________
☐ **Original submission** ☐ **Revision**
Page _____ of _____

I. LEARNING AREA *(check one)*
☒ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☐ Sciences ☐ Physical Development/Health

(Affix label or complete district information.)
COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐
District Name
City
Contact Person: ______________________
Title: ______________________
Phone: (   )

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to write standard English in a grammatical, well-organized, and coherent manner for a variety of purposes.

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Develop and maintain a focus with a clear thesis, a main idea, theme, or unifying event.					
*2. Support and elaborate the main point with specific information or reasons.					
*3. Revise, edit, and proofread.					
4. Explain how advertising benefits consumers in a free enterprise system by listing three examples of benefits they have received, on paper, including the name of the product or service, what the form of media was, and how they responded to the advertisement.					
5. Using two references of the student's choice, prepare on paper a report of not less than 300 words entitled "I believe these advertisements should be banned because."					

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Submission Date ____________
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Page ____ of ____

I. LEARNING AREA *(check one)*
☒ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☐ Sciences ☐ Physical Development/Health

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)
COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐
District Name
City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to use spoken language effectively in formal and informal situations to communicate ideas and information and to ask and answer questions.

Contact Person: ____________
Title: ____________
Phone: ( )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Use voice and physical expression to create a mood.					
2. Discuss orally the steps included in the process of selling, giving examples at each step.					
3. Present a three- to five-minute oral sales presentation on the product or service of their choice to the class.					
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I. LEARNING AREA *(check one)*
☒ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☐ Sciences ☐ Physical Development/Health

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)

COUNTY	DISTRICT	ESC

District Name
City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to listen critically and analytically.

Contact Person: ____________________
Title: ____________________
Phone: ( )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Evaluate the content of an oral message of an appropriate length.					
*2. Judge the sufficiency of detail, the qualifications and credibility of sources, and the effectiveness of solutions proposed in oral messages.					
*3. Evaluate the various techniques used by a source of an oral message to accomplish a purpose.					
4. Identify the personal characteristics of a successful salesperson.					
5. Discuss orally the steps included in the process of selling, giving examples at each step.					

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Submission Date __________________

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Page ____ of ____

I. LEARNING AREA *(check one)*

☐ Language Arts
☒ Mathematics
☐ Sciences
☐ Fine Arts
☐ Social Sciences
☐ Physical Development/Health

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)

COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐

District Name

City

Contact Person: __________________

Title: __________________

Phone: (   )

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to use mathematics skills to estimate, approximate, and predict outcomes, and to judge reasonableness of results.

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Identify information that is irrelevant to a given question.					
*2. Identify information that was used in arriving at a particular conclusion.					
*3. Apply problem-solving procedures to solve or suggest a solution to a given problem.					
4. List three reasons why advertising is a necessary part of any business in a free enterprise system.					
5. Discuss orally the steps included in the process of selling, giving examples at each step.					

Illinois Agricultural Core Curriculum Rev.

Submission Date ____________
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I. LEARNING AREA *(check one)*
☐ Language Arts
☒ Mathematics
☐ Sciences
☐ Fine Arts
☐ Social Sciences
☐ Physical Development/Health

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)

COUNTY	DISTRICT	ESC

District Name

City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to understand and use ratios and percentages.

Contact Person: ____________
Title: ____________
Phone: ( )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Solve problems leading to proportions in arithmetic situations.					
*2. Solve problems involving discounts, sales tax, tips, and commissions.					
*3. Solve problems involving simple interest.					
4. Discuss orally the steps included in the process of selling, giving examples at each step.					
5. Present a three- to five-minute oral sales presentation on the product or service of their choice to the class.					

Advertising and Selling Agricultural Products and Services

Agricultural Business and Management
Agribusiness Operation and Management

Submission Date ______________

☐ Original submission ☐ Revision

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ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)

COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐

District Name

City

Contact Person: ______________

Title: ______________

Phone: (   )

I. LEARNING AREA *(check one)*

☐ Language Arts
☒ Mathematics
☐ Sciences
☐ Fine Arts
☐ Social Sciences
☐ Physical Development/Health

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to perform the computations of addition, subtraction, multiplication and division using whole numbers, integers, fractions or sentences.

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Translate word problem situations to mathematical expressions or sentences.					
*2. Solve word problem situations that have been translated into mathematical sentences.					
*3. Apply properties of numbers and operations to compute mentally or simplify computations.					
4. Collect and mount on separate sheet of paper five examples of what they feel are good advertisements, stating in writing why they feel each advertisement is a "good" advertisement.					
5. Discuss orally the steps included in the process of selling, giving examples at each step.					

ISBE 41-7

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Advertising and Selling Agricultural Products and Services

STUDENT LEARNING OBJECTIVES

Upon completion of their study of this problem area, students will be able to:

1. List three reasons why advertising is a necessary part of any business in a free enterprise system.
2. Explain how advertising benefits consumers in a free enterprise system by listing three examples of benefits they have received, on paper, including the name of the product or service, what the form of media was, and how they responded to the advertisement.
3. Collect and mount on separate sheet of paper five examples of what each student feels are good advertisements stating in writing why they feel each advertisement is a "good" advertisement.
4. Using two references of the student's choice, prepare on paper a report of not less than 300 words entitled "I believe these advertisements should be banned because." The paper should include:
   a. Name of advertised product.
   b. Where it was seen or heard.
   c. Why it should be banned.
   d. How the banning of this advertisement might effect the Constitutional rights of freedom of speech and expression.
   e. What standard is being used to make the decision on banning the advertisement.
5. Identify the personal characteristics of a successful salesperson.
6. Discuss orally the steps included in the process of selling, giving examples at each step.
7. Present a three- to five-minute oral sales presentation on the product or service of their choice to the class.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Advertising and Selling Agricultural Products and Services

PROBLEMS AND QUESTIONS FOR STUDY	INSTRUCTOR'S NOTES AND REFERENCES
1. What are the two main categories of advertising and what are they trying to promote?	
2. What are the primary functions of advertising?	
3. Who are the sponsors of advertisements?	
4. What are the various forms of media used in advertising and what are their purposes?	
5. Why is money spent on advertising so difficult to justify?	
6. What are sales promotions and what is their relationship to advertising?	
7. What is a salesperson's purpose or role in society?	
8. What is a sales transaction?	
9. What makes a successful salesperson?	
10. What is involved in the selling process?	
11. Explain the process of writing up a sales transaction.	
12. What is proper telephone etiquette?	
13. Describe some of the legal responsibilities of the salesperson?	
14. List the common routine tasks required from retail store opening to closing.	

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Advertising and Selling Agricultural Products and Services

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES

1. Begin discussion of this problem area by asking students how important advertising is to our free enterprise system. To stimulate discussion you may wish to have students address some of the following issues:
    a. Is advertising necessary?
    b. What role does advertising play in our economy?
    c. Could business survive without advertising? Why or why not?
    d. Does advertising fulfill a need or create a need?
    e. Is advertising ethical when directed at adults? Children? Why or why not?
    f. Should certain types of advertising be banned? Why and why not? If yes, which advertisements should be banned and why?

2. If students were to prepare an advertising campaign for a product, service, or idea of their own choosing, what factors might they take into consideration to make the campaign most effective?

3. Ask each student which advertising is the most effective on them and have them explain why.

4. Sales promotions often involve the use of free gifts or gimmicks. Have students check over the classroom to see how many of these items are present. Use this as a way of demonstrating how much these items have become an accepted part of our daily lives.

5. Have a representative from a local newspaper, or radio or television station speak to the class on what makes a good advertisement and what special services his or her firm offers to assist in developing advertisements.

6. Have a successful businessperson speak to the class on his/her philosophy concerning advertising.

7. Begin the discussion on selling, salespeople, and the selling process by asking students how important the selling of products, services, and ideas are to our economy.

8. Ask students to discuss the similarities and differences between the functions of advertising and selling.

9. Have students list the selling techniques they have experienced that they found to be the most effective and offensive. Ask students why they feel as they do and why such selling techniques are used.

10. Have a successful salesperson from a local business speak to the class about what makes a successful salesperson successful.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Advertising and Selling Agricultural Products and Services

REFERENCES

*1. *Agribusiness Management.* (1987). Downey, W.D., Erickson, S.P. McGraw-Hill, 1221 Avenue of the Americas, New York, NY 10124-0025.

*2. *Profitable Garden Center Management.* (1982). Bermimger, L. Reston Publishing Company, Inc., A Prentice-Hall Company, Reston, VA 22090.

3. *An Introduction to Agribusiness Management.* (1979). Wills, W.J. Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

4. *I Can —Beginning Course.* Zigler, Zig, McCullough, Manie. Positive Attitudes for America, 13642 Omega, Dallas, TX 75234.

5. *Sell it! With the Million Dollar Attitude.* Weldon, Joel. Nightingale-Conant Corporation, 7300 N. Lehigh Avenue, Chicago, IL 60648.

6. *The Psychology of Winning.* Waitley, Denis. Nightingale-Conant Corporation, 7300 N. Lehigh Avenue, Chicago, IL 60648.

NOTE: Items 4-6 are professionally prepared motivational or positive thinking tapes which can be used for the motivation of students planning courses in sales.

7. *Agribusiness Selling Services* (VAS Filmstrip Set #MF383); *Applying for a Job* (VAS Unit #U6001B); *Human Relations in Agricultural Businesses* (VAS Unit #U6003); *Motivating Workers in an Agricultural Business* (VAS Unit #U6016); *International Agriculture Exchange and Work Opportunities* (VAS Unit #U6021); *Marketing Products and Merchandise in Agricultural Businesses* (VAS Unit #U6026); *Merchanising Agricultural Products* (VAS Unit #U6027); *Salesmanship in Agricultural Business* (VAS Filmstrip #F391); *Human Relations in Agricultural Business* (VAS Filmstrip #F392). Vocational Agriculture Service, College of Agriculture, University of Illinois, 1401 S. Maryland Drive, Urbana, IL 61801. (217) 333-3871.

8. *Advertising.* (1980). Eggland, S., Sass, S. Center for Career Curriculum Development, Division of Continuing Education, University of Texas at Austin.

9. *Advertising and Display in Agribusiness.* (1979). Mcguire, J.E. McGraw-Hill Publishing Company, New York, NY.

10. *Human Relations in Agribusiness.* (1980). Hillison, J., Crunkilton, J. McGraw-Hill Publishing Company, New York, NY.

11. *Selling in Agribusiness.* (1979). Miller, L. McGraw-Hill Publishing Company, New York, NY.

12. *Agricultural Business Sales and Marketing.* (1984). Stewart, B.R., McCaskey, M.J., Mulinix, M.K. Instructional Materials Laboratory, University of Missouri-Columbia, Columbia, MO.

13. *Applied Communications.* Curriculum Publications Clearinghouse, Western Illinois University, Macomb, IL 61455.

*Indicates highly recommended reference

INSTRUCTIONAL RESOURCES

These resources are intended for use by teachers in planning and teaching the materials for this problem area and may be adapted to fit the teaching method(s) used.

INFORMATION SHEET #1 — The Functions of Advertising

INFORMATION SHEET #2 — Sources and Distribution of Advertising

INFORMATION SHEET #3 — Methods Used to Communicate Advertising

INFORMATION SHEET #4 — Sales Promotions

INFORMATION SHEET #5 — Successful Advertising Programs

INFORMATION SHEET #6 — Point of Purchase

INFORMATION SHEET #7 — Professional Assistance

INFORMATION SHEET #8 — Selling

INFORMATION SHEET #9 — Successful Salespeople

INFORMATION SHEET #10 — The Process of Selling

INFORMATION SHEET #11 — Retail Sales Duties

TRANSPARENCY MASTER #1 — Categories of Advertising

TRANSPARENCY MASTER #2 — Sources and Distribution of Advertising

TRANSPARENCY MASTER #3 — Where Does Selling Occur in the Marketing Chain

TRANSPARENCY MASTER #4 — Characteristics of a Successful Salesperson

TRANSPARENCY MASTER #5 — Education, Training, and Experience

TRANSPARENCY MASTER #6 — The Process of Selling

INFORMATION SHEET #1

The Functions of Advertising

Advertising performs many functions for all sections of society. Some of these functions are listed below.

1. Advertising makes potential customers aware of a product.
2. Advertising assists the selling efforts of salespeople.
3. The fact that an advertisement appears at all may imply a product's greater worth or value.
4. National advertising may add additional value to a product beyond local advertisements, in the minds of consumers.
5. Advertisements may serve as motivators causing consumers to look for a specific item.
6. Advertisements may serve to remind people that an item is available.
7. From an institutional point of view, advertisements could be educational and be used to help customers learn about the institution.
8. Advertisements may be educational to help consumers receive greater benefit from products, services, or ideas.
9. Advertising may serve to strengthen the feeling that the correct decision was made about recent purchases.

It is important for students to be aware that advertising and sales are vital, necessary parts of the marketing system operating under the free enterprise system. Advertising and sales perform a dual role for any legitimate business enterprise. First is the role of generating a profit for the business enterprise. Without profit businesses of any type would not exist for long. The second and equally vital role which many people lose sight of is helping people (consumers). The product, service, or idea being advertised and sold has as its primary function improving the quality of life for the consumer. This improvement can come in many forms, for example:

1. saving money.
2. saving time.
3. greater convenience.
4. better health.
5. greater safety.
6. easier operation.
7. imparting happiness.
8. improving leisure time.
9. improving management skills and techniques.
10. increasing knowledge.
11. satisfying basic needs.

These are just a few of the ways in which the quality of life can be improved.

With some careful thought it is easy to see how these can be transformed into customer motives for buying and therefore where a sales appeal is appropriate.

INFORMATION SHEET #2

Sources and Distribution of Advertising

Transparency Master #2 depicts the sources of advertisements and how they are distributed. As is indicated in the concept map, most advertising is generated by the manufacturers of the product and may take one of these routes:

1. To the left is the path advertising will follow in an effort to get the distributor and retail dealer to carry a product. Advertisements here are directed at these businesses without ever being seen by the final consumer.

2. The center route is generally the path of national advertisements. The manufacturers will generate advertisements to stimulate demand by the consumer thereby causing the product to be pulled through the system.

3. The right-hand system is a portrait of cooperative advertising and locally generated advertisement. The first path would have the manufacturer and dealer share the expense of providing the advertisement. The advertisement would then be prepared by the manufacturer with the names of the manufacturer and local dealer on it. The advertisement would be distributed through the local dealer. Brochures, flyers, pamphlets, and radio/television advertising would have the name of the local dealer imprinted on materials or inserted in the message.

4. Manufacturers may also generate advertising materials such as store displays, banners, and posters for use at the retail level. The second line running from the manufacturer to the dealer depicts this flow. A second line from the dealer to the consumer depicts the flow of locally generated and produced advertising. The expense of the last advertising route would be covered by the dealer alone.

INFORMATION SHEET #3

Methods Used to Communicate Advertising

The methods used to communicate advertising can vary greatly. The medium used is directly related to the expense, the focus of the advertisement, and the consumer(s) the advertisements intend to attract.

Television is the most expensive medium and is generally used for national advertising. Smaller communities may have a local station which permits local businesses to advertise at a reduced cost. However, this method is still quite expensive. Radio is less expensive and very popular because it can reach customers at times when no other medium can do so. For example, people can often listen to the radio while working, in restaurants, retail stores and shopping malls, or enjoying a leisure activity. Mental pictures or images can be created on the radio that are not possible or too expensive to create in any other manner.

The newspaper is an even less expensive medium that has varying degrees of success. It is difficult to measure the effectiveness of newspaper advertising unless a coupon or form that needs to be completed accompanies the advertisement. These coupons or forms would be used to attract customers and used for a giveaway or special discount, but could also measure effectiveness of the advertisement.

Handbills, flyers, and letters can be used in direct mail advertising. These are the least expensive method and allow the dealer to get the greatest return for dollars spent, because a very specific group can be targeted to receive the advertisement.

Trade associations usually have trade publications that will carry advertisements from manufacturers to distributors to dealers. It is important that business owners belong to the related trade association so that they can remain current on new products, services, and ideas through trade journals.

Advertising budgets are always a difficult issue to deal with because it is very difficult to show the results of expenditures in advertising. There is also the temptation to cut the advertising budget when there is a slump in sales, but in fact this is the time when this budget might even need to be increased.

Sponsorship of local teams or activities in the community or neighborhood are also popular. These methods can be costly or quite inexpensive depending on the amount of cooperation with other businesses.

The least expensive and perhaps the most effective form of advertising is "word of mouth." To have a satisfied customer give a positive testimonial to a friend or neighbor costs nothing and could very well result in an easy sale.

Don't forget the "yellow pages" as this is a very useful tool for the consumer when shopping.

INFORMATION SHEET #4

Sales Promotions

In addition to what is thought of as media advertising there are many other ways in which the sale of products or services is encouraged. The list below is not intended to be all inclusive, but should give you an idea of the types of gifts and gimmicks used to stimulate sales.

For Consumers

Pens
Pencils
Caps
Jackets
T-Shirts
Combs
Key chains
Rain gauges
Samples of products
Note pads
Coffee mugs
Drawings to win trips
Dinners, vacations
"How to" workshops
Trade shows
Balloons
Bumper stickers

For Owners and Employers

Dinners
Trips
Vacations
Seminars
Workshops
Educational, technical meetings
Bonuses
Trade shows

All of the above are costly and can get out of hand unless closely monitored. Competition can force a business to get involved in such practices, but caution is advised.

INFORMATION SHEET #5

Successful Advertising Programs

In order that any advertising program be successful the following should be carefully considered:

1. An understanding and dedication to the idea that advertising is a necessary expenditure for any business.
2. A very specific well-prepared plan to expand the consumer base.
3. Careful consideration and preparation of an advertising budget.
4. A creative program that combines manufacturer and local plans, products, and ideas.
5. A method of evaluation to check effectiveness and a method of revision as indicated by evaluation feedback.

INFORMATION SHEET #6

Point of Purchase

A particularly interesting and very effective method of advertising is called "point of purchase." This method consists of displays within or just outside the retail outlet to attract customers. The elements used to make these most effective is to try to incorporate as many of the five senses as possible along with psychological approaches. Many manufacturers direct this advertising effort directly at one of these:

1. Sight — use of color, shape, size, motion, location.
2. Sound — use of jingles, slogans, songs, and sounds associated with the use of the product.
3. Touch — having the item there to be touched to feel the texture, smoothness, flexibility, or strength.
4. Taste and smell — often associated with food and giving free samples, but also with perfumes, flowers, and cosmetics.

Psychological approaches try to paint a mental picture of the consumer's owning and using the product or service. Ownership is the key concept to get across.

INFORMATION SHEET #7

Professional Assistance

Professional assistance is available for helping to prepare the most effective advertisement within budget constraints.

Call the media, television, radio, newspaper, etc. for assistance. Print shops can provide professional help at little or no cost.

Manufacturers often supply aid to dealers to help make more effective use of materials provided by the manufacturers. Help may also be available to assist in preparing a local advertising program.

Professional advertising agencies are available which can aid in developing any or all parts of an advertising program. This method can be expensive, but a professionally prepared program could last a long time and generate many times its costs in new and repeat sales.

INFORMATION SHEET #8

Selling

In our free enterprise system, in order that businesses remain successful there must be an ongoing series of sales transactions. These sales transactions consist of the exchange of a product, service, or idea for something that has monetary value. As the activity of selling implies, sales are made which will involve personal selling, a salesperson, at some time. Between the manufacturer and the final consumer someone had to convince someone else that the product, service, or idea had value for the sales transaction to occur.

To put it very simply, all that is required of a salesperson is to convert customer wants into needs; then the sale is completed. Obviously, the process that is required to get this job done can be extremely complex, and the methods used are as varied as the products and services available for sale. There is an excellent chance your school or local library contains many books on selling techniques. Bookstores often devote entire sections of the store just to books on how to sell.

Viewed from the proper perspective, selling can be a most satisfying and rewarding profession. Successful sales people are some of the most highly paid people in the country. Sales training and expansion can lead to positions in any level of management from sales manager to chief executive officer of a major corporation. The key to sales success is the same as for any level of management, people skills. Understanding what motivates people and how you as a salesperson can appeal to that motivation is vital.

There are, however, some disadvantages to the sales profession just as there are disadvantages to any profession. In order to be successful you must be willing to:

1. Handle rejection gracefully.
2. Work long hours.
3. Study trends and changes in technology and the economy.
4. Be self-motivated.
5. Look at the bright side in the face of adversity.

Depending on the sales field you enter, some additional disadvantages may exist such as:

1. Extended periods of travel.
2. Irregular pay.
3. Being on your own, perhaps for an extended period.

But the rewards are great and you can take a tremendous amount of satisfaction in your own effort and accomplishment.

INFORMATION SHEET #9

Successful Salespeople

The selling process takes place throughout the marketing chain (see Transparency Master #3). At each level the salesperson's duties and responsibilities may be quite difficult. If you move up the chain from final consumer to manufacturing firms the amount of time spent on the job generally increases, as does the amount of travel required and often the pay.

There are some characteristics which seem to apply to the majority of successful salespeople. These characteristics include the following:

1. Determination and desire.
2. Self-motivation.
3. Enthusiasm.
4. Ability to work with people.
5. Self-improvement.
6. Sensitivity to people.
7. Intelligence.
8. Honesty.
9. Ability to communicate.
10. Neat appearance.

In addition to the above characteristics the following listed items of education, training, and experience make up a vital part of the requirements for a successful salesperson:

1. Technical background in agriculture.
2. Communication and Social Science courses.
3. Agricultural Business Management and support courses.
4. Extracurricular activities.
5. Work experience.

The characteristics seem self-explanatory. However, a further explanation of education, training, and experience is necessary.

Technical background in agriculture — Education at this level gives a potential salesperson the background necessary to learn specific information about products or services on the job.

Communication and Social Science courses — People skills are basic to success in sales. What makes people do what they do is very important to understand. Courses in communication and the social sciences will help salespersons understand what motivates people to respond as they do. This knowledge then can be used in the selling process.

Agriculture Business Management and support courses — Depending on the customers you will be working with and your career goals, the more management knowledge you can demonstrate the greater your chances for success. People in all walks of life are becoming more and more sophisticated about managing everything from household and personal affairs to small businesses to major corporations. If you are to meet the needs of these people you must also possess these skills. If your goal is to advance out of sales into management, you must also possess these skills. Courses in agriculture business management, accounting, and law are excellent support courses.

Extracurricular activities — Any time you have the opportunity to accept leadership roles or committee experience, whether it be in the FFA or SAE or any other school, community, or work activity this knowledge gained will prove invaluable to future success as a salesperson.

Work experience — The simple fact that you have worked at one job for some time without serious problems demonstrates many qualities necessary for success as a salesperson. You can go back to the list of characteristics for a successful salesperson and match those to requirements for your present job, whether part-time or a SAE, to see how many apply.

INFORMATION SHEET #10

The Process of Selling

(Use with Transparency Master #6)

Preparation — to become knowledgeable about the product or service, the market and the customers being served. In addition, prospecting for customers, qualifying prospects, and contacting customers are parts of preparation which will be discussed later.

Knowledge — not only product knowledge but knowledge of markets, competition, customer wants and needs, uniqueness of individual customers, changes in technology and people skills.

Prospecting — identifying and locating potential customers through the use of various methods of calling on people, setting appointments, and following up on leads.

Qualifying prospects — a key area to success is the ability to determine, sometimes in a matter of minutes, if the prospect really can become a customer. Errors in judgement can result in lost time and energy as well as lost income.

Planning the sales call involves four basic steps:

1. Collecting information on the customer.
2. Determining the sales-call objective.
3. Determining the sales-call strategy.
4. Preparing specific parts of the active sales call.

Making contact — being in the right place at the right time whether in a retail store or meeting with a customer it is necessary to be there when the customer is ready. Making and keeping appointments in a timely manner is necessary because just as your time as a salesperson is valuable so too is the customer's time.

The parts of the actual selling activity:

I. Approach
  A. dress
    1. appropriate for the situation
    2. appropriate for the product or service
    3. appropriate for the customer
  B. respect
    1. for the customer
    2. for customer's property
    3. for customer's values
  C. greeting
    1. friendly
    2. confident
  D. introduction
    1. clear statement of:
      a. your name
      b. company's name
      c. customer's name
    2. use of first names
  E. opening remarks
    1. prepared but adaptable
    2. unprepared but situational

II. Rapport
  A. establish a comfortable situation
  B. encourage conversation

III. Questions
  A. focus attention
  B. determine wants and needs

IV. Generating interest
  A. bringing customer to the point
  B. customer awareness that product or service will:
    1. meet needs
    2. save time, money, or effort
    3. improve the quality of life

V. Presentation
  A. to generate a favorable response
  B. match time and manner of presentation to situation
  C. transaction
  D. reading nonverbal as well as verbal messages
    1. respond
    2. look for interest openings
  E. adding detail called for by uniqueness of situation

VI. Conversion
  A. features to advantages
  B. advantages to benefits
  C. benefit is reason to buy

VII. Product
  A. in response to customer needs
  B. as backup for claims
  C. sources of proof
    1. demonstration
    2. illustrations
    3. drawing a comparison
    4. use of testimonials
    5. result of independent manufacturer's testing
    6. preprinted materials
    7. critical analysis

VIII. Conviction
  A. internal belief that needs are met
    1. give visual image
      a. customer receiving benefits
      b. customer using product or service
  B. asking probing questions requiring positive answers

IX. Objections
  A. customer negative response
    1. to features or benefits
    2. to sources of proof
  B. turning objections into reason to buy
    1. ask questions, probe
    2. reword objection and clarify
    3. boomerang
      a. restate customers objection
      b. state how objection is in fact benefit
    4. yes, but
      a. agree with objection
      b. but-turn this into a reason to buy
        i. analyze what customer is saying
        ii. emphasize why product was made in such a manner that it is a benefit
    5. deny
      a. it may be the case that customer is under false impression
      b. correct the false impression
    6. accept
      a. it may be the case that objection is correct and valid
      b. consider weighing pros and cons
    7. ignore
      a. continue on as if it were not stated
      b. CAUTION this may be a serious issue that may have to be dealt with later

X. Close
  A. when
    1. whenever you feel customer is in agreement
    2. after handling objections
    3. watch for clues all the time
  B. methods
    1. ask for order, assume it is "ok"
    2. summarize benefits, ask for order
    3. offer a choice between two alternatives, not something and nothing
    4. urgency or special feature
      a. limited time offer
      b. only on this model
      c. only with this package

XI. Sales accomplished
  A. compliment customer on decision
  B. say THANK YOU

XII. "NO"
  A. briefly restate positive points, ask again
  B. accept fact, leave on good terms
  C. try for new appointment

XIII. Follow-up
Depending on product or service a follow-up to check for problems or concerns may be appropriate because:
  A. strengthens customer decision to buy
  B. may mean sale of related items
  C. may mean referral to other customers

Adapted from: Downey, W.D., Erickson, S.P. (1987). *Agribusiness Management.* McGraw-Hill Publishing Company, 1221 Avenue of the Americas, New York, NY. pp 318-344.

INFORMATION SHEET #11

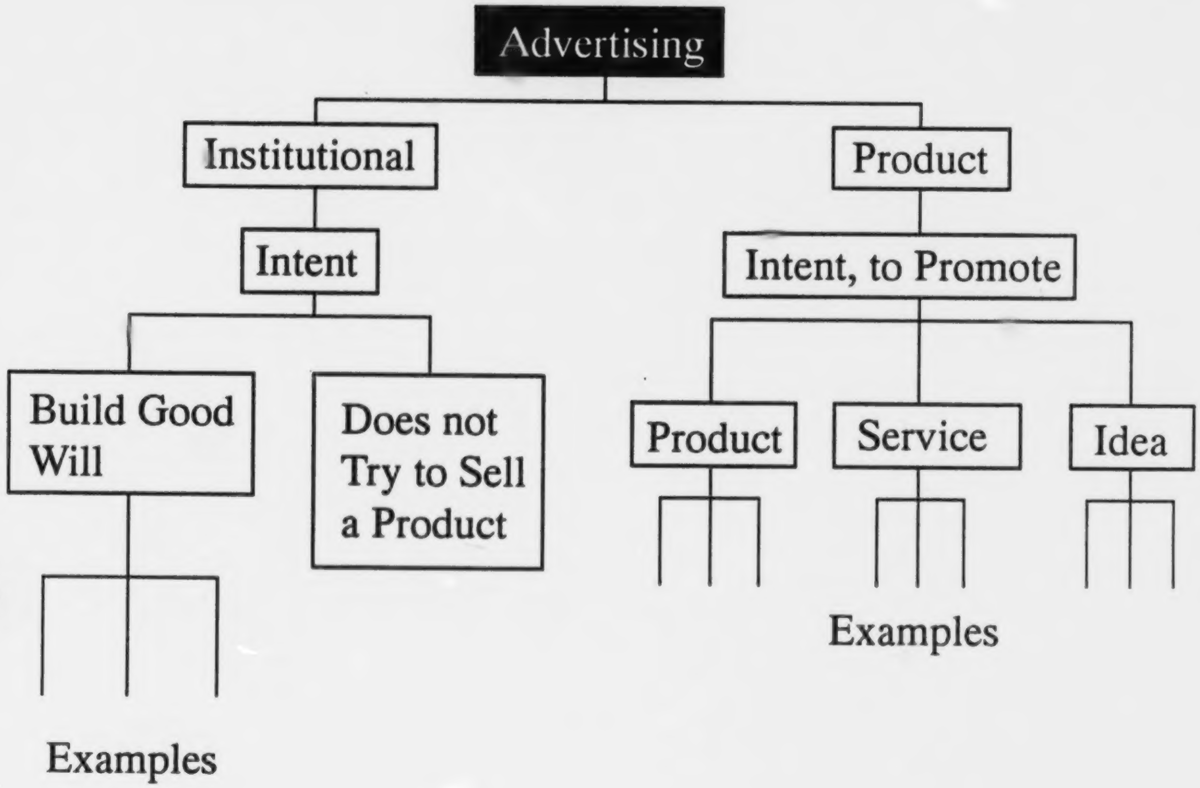
Retail Sales Duties

In addition to advertising, promotion and selling there are many other tasks with which a salesperson must become familiar. Depending on whether the salesperson is active in making sales calls or working with a retail store, these tasks may be considerable. Listed here are many of those tasks which, in some cases, are quite unique to individual firms. However, a basic understanding of these tasks is very important.

Open store or department
Process cash sales transactions
Process credit transactions
Figure sales tax
Package merchandise
Handle customer complaints
Close out cash register
Close store or department
Process returns
Meet and greet people
Maintain clean, neat environment
Arrange deliveries
Order supplies and merchandise
Process orders (incoming, outgoing)
Stock shelves
Use telephone
Do inventories
Maintain accurate records
Explain credit options
Explain guarantees, warranties
Provide special customer services
Use part numbers and model numbers for service and repair
Handle mail orders
Explain use, storage, and disposal of hazardous chemicals

TRANSPARENCY MASTER #1

Categories of Advertising



Advertising

Institutional

Intent

Build Good Will

Examples

Does not Try to Sell a Product

Product

Intent, to Promote

Product

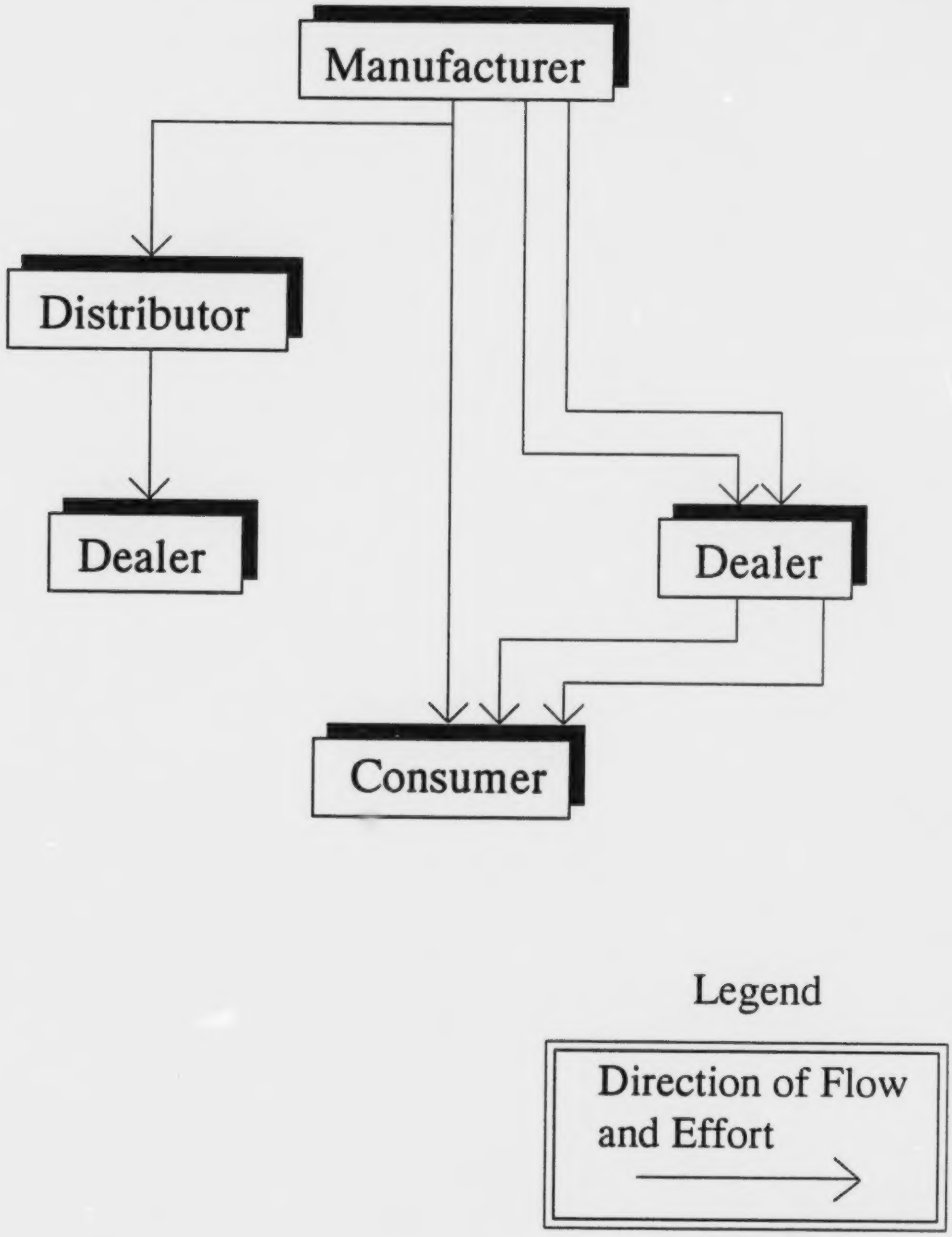
Service

Idea

Examples

TRANSPARENCY MASTER #2

Sources and Distribution of Advertising


Manufacturer
Distributor
Dealer
Dealer
Consumer
Legend
Direction of Flow and Effort

TRANSPARENCY MASTER #3

Where Does Selling Occur in the Marketing Chain

Selling to manufacturing firms

⇓

Selling to processing firms

⇓

Selling to distributors

⇓

Selling to wholesalers

⇓

Selling to retailers

⇓

Selling to final customers

TRANSPARENCY MASTER #4

Characteristics of a Successful Salesperson

Determination and desire

Self-motivation

Enthusiasm

Ability to work with people

Self-improvement

Sensitivity to people

Intelligence

Honesty

Ability to communicate

Neat appearance

Adapted from: Downey, W.D., Erickson, S.P. (1987). *Agribusiness Management*. McGraw-Hill Publishing Company, 1221 Avenue of the Americas, New York, NY. pp. 309-310.

TRANSPARENCY MASTER #5

Education, Training, and Experience

Technical background in agriculture

Communication and social science courses

Agricultural business management support course

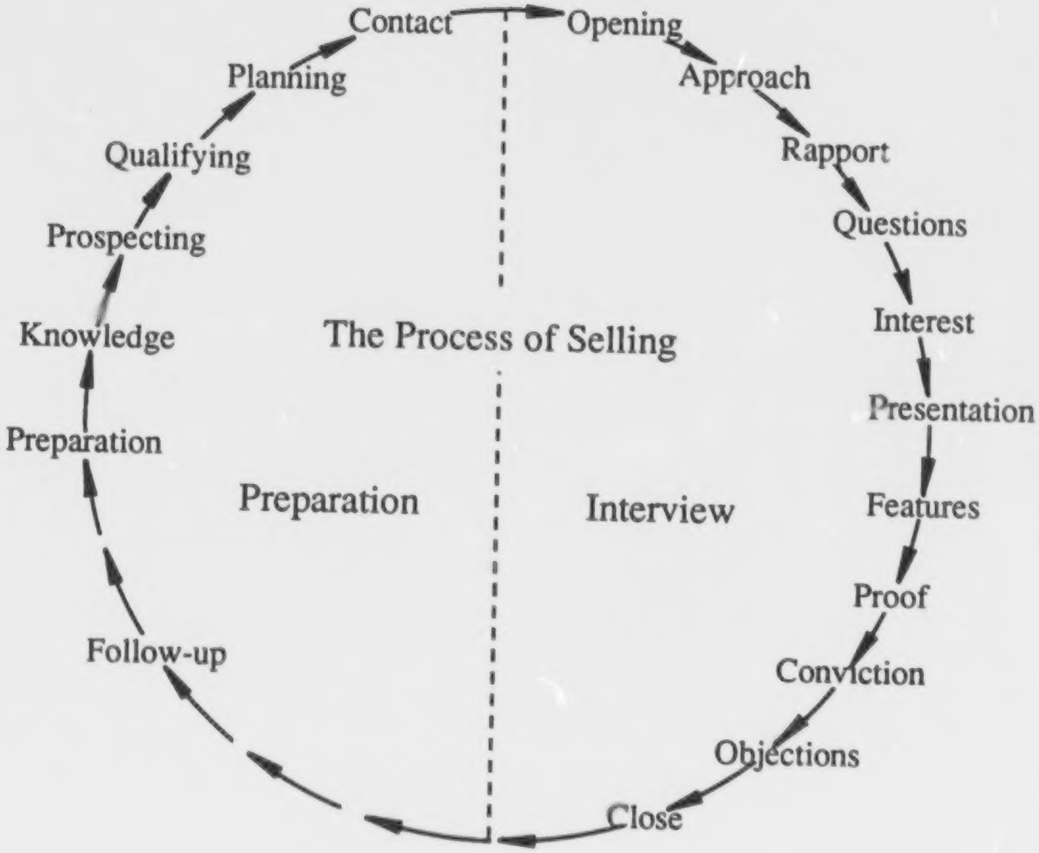
Extracurricular activities

Work experience

Adapted from: Downey, W.D., Erickson, S.P. (1987). *Agribusiness Management.* McGraw-Hill Publishing Company, 1221 Avenue of the Americas, New York, NY. pp. 311-312.

TRANSPARENCY MASTER #6

The Process of Selling


Contact
Opening
Planning
Approach
Qualifying
Rapport
Prospecting
Questions
Knowledge
The Process of Selling
Interest
Presentation
Preparation
Preparation
Interview
Features
Proof
Follow-up
Conviction
Objections
Close

Adapted from: Downey, W.D., Erickson, S.P. (1987). *Agribusiness Management.* McGraw-Hill Publishing Company, 1221 Avenue of the Americas, New York, NY. p. 319.

STUDENT ACTIVITIES

STUDENT WORKSHEET #1 — Improving the Quality of Life

STUDENT WORKSHEET #2 — I Bought This Because

STUDENT WORKSHEET #3 — Point of Purchase

STUDENT WORKSHEET #4 — Sales Promotion Items

STUDENT WORKSHEET #5 — School Display

STUDENT WORKSHEET #6 — Sales Presentation

For additional activities, teachers may refer to the "Suggested Teaching Activities and Procedures" section in the Instructor's Guide.

STUDENT WORKSHEET #1

Improving the Quality of Life

Each student will collect one advertisement for six of the eleven focuses of advertising listed below, mount each advertisement on a separate sheet of paper, identify the focus of the advertisement, and explain how the product, service, or idea is designed to improve the quality of life. The focuses are:

1. Saving money
2. Saving time
3. Greater convenience
4. Better health
5. Greater safety
6. Easier operation
7. Imparting happiness
8. Improving leisure time
9. Improving management skills and techniques
10. Increasing knowledge
11. Satisfying basic needs

STUDENT WORKSHEET #2

I Bought This Because

Each student will prepare an outline to be handed in and which the student can use to give a two-minute talk to the class on why a recent purchase was made. Included in the outline and talk must be:

1. Name of product or service.
2. Where it was purchased.
3. What motivated the student to purchase the product or service.
   a. If it was advertisement, how did it influence the student.
   b. If it was a salesperson, what did the salesperson say and/or do to convince the student.
   c. If other, such as friend, neighbor, peer pressure, teacher, relative, etc., tell who and why.
4. Is student satisfied with the purchase? Why or why not?

STUDENT WORKSHEET #3

Point of Purchase

Each student will prepare a paper of not more than 300 words to be read in class and will hand in on the topic "The Point of Purchase Advertisement" or "This Display Really Attracted my Attention Because." Included in the paper must be:

1. A picture or drawing, or some representation of the "POP."

2. An explanation of why the student felt the "POP" was so effective, and how it affected one or more of the five senses.

3. Where was it located.
    a. Inside or outside a business.
    b. In an aisle.
    c. In the parking lot.
    d. In a window.

4. How they responded to the "POP."
    a. Purchased the product or service.
    b. Told someone about it.

STUDENT WORKSHEET #4

Sales Promotion Items

Each student will collect five different gifts or gimmicks to bring to class and be prepared to discuss in class the following:

1. What is it?

2. Where was it originally obtained?

3. What was the intent of giving it away?
    a. Was it to serve as reminder?
    b. Was it used to close a sale?
    c. Was it a reward for making a purchase?

4. What if any appeal is attached to the item, such as an appeal to the quality of life?

STUDENT WORKSHEET #5

School Display

Each student shall prepare a portfolio containing all the necessary information to do a complete display, that can be set up in the school for at least one week, advertising a particular school function or activity. Examples of such functions or activities include FFA week, College night, sale of fruit, garden seed, bedding plants or flowers for special occasions, or homecoming. The portfolio will be judged by classmates with instructor guidance, and the display representation rated best will actually be set up at the appropriate time. The portfolio should include the following:

1. Name of the function or activitiy being advertised or promoted.
2. Sketch of how the display will be set up.
3. All copy (words, phrases, slogan, symbols).
4. Colors to be used.
5. Sample of any special materials required.
6. Estimated cost.
7. Size of area required.
8. Brief explanation of how the display is supposed to influence someone. Example: Explain use of color, copy, and motivational factors of items in display and their locations.

In order that the greatest benefit can be achieved from this exercise the following activities are recommended:

1. The winning display must be set up.
2. More than one display can be done if school area lends itself to such an arrangement.
3. The display may be set up in a retail store window or at a shopping mall event.
4. A questionnaire can be developed to survey people that observe the display. This questionnaire should be used to determine the effectiveness of the display compared to its stated purposes in the portfolio.
5. Results of the survey should be discussed in class in a formative manner to assist the students in developing a better understanding of display techniques and effectiveness.

Display Design Product Checklist

Student's Name ______________________________ **Date** __________

Product to be evaluated ______________________________

Directions: Before attempting this task for mastery, the student should carefully review this checklist. Evaluation will be made on the basis of this checklist. Mastery will be evidenced by scoring at least _____ out of _____ points.

Action	Points Possible	Points Received
Use of Principles of Design		
1. Shows balance.	______	______
2. Has contrast.	______	______
3. Emphasis on main theme.	______	______
4. Harmonizes.	______	______
5. Proper proportions of objects.	______	______
6. Shows unity.	______	______
7. Repetition.	______	______
8. Rhythm.	______	______
Use of Design Elements		
9. Color.	______	______
10. Direction.	______	______
11. Lines.	______	______
12. Shapes.	______	______
13. Size.	______	______
14. Texture.	______	______
15. Value.	______	______
16. Weight.	______	______
Measure of Effectiveness		
17. Establishes a theme.	______	______
18. Describes the product or service.	______	______
19. Shows how the product or service is used.	______	______
20. Relates the main benefits and features.	______	______
21. Sketch shows the general outlay, plan of action, and materials needed.	______	______
Comments:	Total Points Possible	Points or % Received

Minimum Mastery Level ______________________________

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STUDENT WORKSHEET #6

Sales Presentation

Each student shall prepare a sales presentation, of not more than 5 minutes, to be given to the class, orally, on a product or service of the student's choice.

Classmates shall consider themselves potential customers and, using the evaluation sheet, evaluate each presentation. It must be stressed here that this is to be a formative evaluation which is designed to assist all students in developing or improving sales techniques. The exercise can also be used to help students appreciate and understand how a salesperson might try to influence the students in the "real world."

A brief outline should also be written by each student and handed in prior to the sales presentation. Two goals can be accomplished with this outline; first, learning whether the student has chosen a product or service appropriate for the classroom, and second, learning whether the student has organized the presentation in a logical manner. It would be beneficial to require the outlines at least a week in advance of the presentation to allow time for feedback and for students to make adjustments, if needed.

You may also wish to add some motivational effect to the assignment by requiring the sales presentations to be on an upcoming school-related sale or event. The sales presentation judged best or perhaps the five best could be presented to the entire school at an assembly. You may also choose to make the sales presentation follow the format of a radio commercial and have the one or ones judged best included in daily announcements.

Sales Presentation Performance Checklist

Student's Name ______________________________ **Date** ______________

Product to be sold ______________________________________

Directions: Before attempting this task for mastery, the student should carefully review this checklist. Evaluation will be made on the basis of this checklist. Mastery will be evidenced by scoring at least ______ out of ______ points.

Action	Points Possible	Points Received
Approach		
1. Was well prepared.	______	______
2. Method of approach was appropriate for the product and customer type.	______	______
3. Approach created interest.	______	______
4. Established favorable impression.	______	______
5. Determined prospective customer's need or problem.	______	______
Presentation or Demonstration		
6. Had a well-organized sales presentation.	______	______
7. Matched the customer's needs to product benefits.	______	______
8. Pointed out the most obvious benefits first.	______	______
9. Got the customer involved, appealed to 5 senses.	______	______
10. Kept the communications positive.	______	______
11. Kept the customer motivated.	______	______
12. Endeavored to close the sale during the presentation.	______	______
Overcoming Resistance		
13. Established whether it was an objection or an excuse.	______	______
14. Use the objection to pin-point needs of the customer.	______	______
15. Objection was handled with a method appropriate to the situation.	______	______
16. Endeavored to close the sale while handling objections.	______	______
Close		
17. Thorough in explaining all the features.	______	______
18. Stressed the major benefits.	______	______
19. Used appropriate techniques to close the sale.	______	______
20. Reassured the customer after the close.	______	______
21. Suggested other items after the close.	______	______
22. Made necessary arrangements for delivery.	______	______
Comments:	Total Points Possible	Points or % Received

Minimum Mastery Level ______________________

Reproduced from *Agricultural Business Sales and Marketing*. Stewart, B.R., McCaskey, M.J., and Mullinix, M.K. (1984). Permission granted by Instructional Materials Laboratory, University of Missouri-Columbia, Columbia, MO.

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Operating the Agribusiness

RELATED PROBLEM AREAS:

1. Planning and Organizing the Agribusiness
2. Managing Entrepreneurship Opportunities in Agriculture
3. Identifying and Practicing Ethics in Agricultural Occupations (Central Core Cluster)
4. Using Microcomputers in Agribusiness Management

PREREQUISITE PROBLEM AREA(S): None

LEVEL: Preparatory

OCCUPATIONAL TASKS ADDRESSED:

Agricultural Business and Management

Duty H: Managing the Business

1. Conduct periodic inspection of merchandise
2. Conduct inventory of merchandise
3. Maintain inventory records
4. Plan work schedules
5. Determine labor needs
6. Evaluate employee performance
7. Maintain quality control records
8. Evaluate agribusiness productivity
9. Purchase machinery and equipment
10. Utilize computerized inventory control systems
11. Establish computerized inventory control systems

STATE GOALS FOR LEARNING

In planning the instruction for this problem area, teachers can promote the development of several student learning objectives which are related to the State Goals for Learning in Language Arts and Social Sciences. These objectives are listed on the Learning Assessment Plan forms included on the following page(s). Those learning objectives marked with an asterisk (*) are taken from the sample lists provided by the Illinois State Board of Education.

Illinois Agricultural Core Curriculum
Agricultural Education 124 Mumford Hall 1301 W. Gregory Drive University of Illinois Urbana, IL 61801

Director: Dale A. Law, Ed.D.
Principal Investigator: Jerry D. Pepple, Ed.D.
Research Assistant: James K. Shinn

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Submission Date _______________ ☐ Original submission ☐ Revision	Page ____ of ____

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)

COUNTY	DISTRICT	ESC

District Name

City

Contact Person: ____________________
Title: ____________________
Phone: (   )

I. LEARNING AREA *(check one)*

☐ Language Arts
☐ Mathematics
☐ Sciences
☐ Fine Arts
☒ Social Sciences
☐ Physical Development/Health

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to apply the skills and knowledge gained in the social sciences to decision making in life situations.

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Compare anticipated and unanticipated outcomes which result from a plan of action.					
*2. Identify the attitudinal skills which affect worker performance.					
*3. Understand how employers, labor unions, managers, and workers interact with one another to achieve a common goal.					
*4. Evaluate the costs and benefits of a particular course of action.					
*5. Understand the principles of money management including budgeting.					
*6. Analyze the management of human and material resources.					
7. Develop a plan for monitoring the efficiency of employees in a continuous production system.					
8. Apply knowledge and skills learned in this problem area to FFA or SAE programs.					

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Submission Date________________

☐ Original submission ☐ Revision

Page ____ of ____

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)

COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐

District Name

City

Contact Person: ________________

Title: ________________

Phone: (   )

I. LEARNING AREA *(check one)*

☒ Language Arts
☐ Mathematics
☐ Sciences
☐ Fine Arts
☐ Social Sciences
☐ Physical Development/Health

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to write standard English in a grammatical, well-organized, and coherent manner for a variety of purposes.

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Support and elaborate the main point with specific information or reasons.					
*2. Organize ideas clearly, coherently, and logically within the major discourse structures.					
*3. Use imagination to develop new ideas in a written presentation.					
4. Identify which type of production is used primarily with agricultural products and explain why.					
5. Prepare a paper of not less than 500 words explaining the production plan the student has prepared, which also demonstrates his or her understanding of the four factors to be considered in planning production.					

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Submission Date ____________

☐ Original submission ☐ Revision

Page ____ of ____

I. LEARNING AREA *(check one)*

☒ Language Arts
☐ Mathematics
☐ Sciences
☐ Fine Arts
☐ Social Sciences
☐ Physical Development/Health

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)

COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐

District Name

City

Contact Person: ____________

Title: ____________

Phone: (   )

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to use spoken language effectively in formal and informal situations to communicate ideas and information and to ask and answer questions.

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Use language for a variety of purposes.					
*2. Use imagination to develop new ideas in an oral presentation.					
3. List and explain the four methods of production.					
4. List and explain how the four factors to be considered in planning a production system are interrelated.					

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Submission Date ______________
☐ Original submission ☐ Revision
Page ____ of ____

ILLINOIS STATE BOARD OF EDUCATION
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Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)
COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐
District Name
City

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☒ Mathematics ☐ Social Sciences
☐ Sciences ☐ Physical Development/Health

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to listen critically and analytically.

Contact Person: ______________
Title: ______________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Analyze the main ideas from a variety of kinds of oral messages and relate those ideas to the central theme.					
*2. Identify the sequence of ideas from spoken messages.					
*3. Analyze the relationship among ideas in an oral message.					
4. Prepare a plan showing the continuous production process for a product of the student's choice.					
5. Prepare a plan showing the intermittent production process for an agricultural product of the student's choice.					
233					233

ISBE 41-78 (1/88)

Submission Date ____________
☐ Original submission ☐ Revision
Page ____ of ____

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)

COUNTY	DISTRICT	ESC

District Name

City

I. LEARNING AREA *(check one)*

☒ Language Arts
☐ Mathematics
☐ Sciences
☐ Fine Arts
☐ Social Sciences
☐ Physical Development/Health

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to read, comprehend, interpret, evaluate, and use written materials.

Contact Person: ____________
Title: ____________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Use, synthesize, and analyze information from a variety of sources to enhance understanding, e.g. form opinions based upon a variety of information, to compare and contrast, to verify information, and to expand knowledge.					
2. Prepare a paper of not less than 500 words explaining the production plan the student has prepared, which also demonstrates his or her understanding of the four factors to be considered in planning production.					

ISBE 41-76 (1/88)

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Operating the Agribusiness

STUDENT LEARNING OBJECTIVES

Upon completion of their study of this problem area, students will be able to:

1. List and explain the four methods of production.
2. Determine which of the methods of production were used to get a product from raw material to the consumer.
3. List and explain the uniqueness of the two types of production.
4. Identify which type of production is used primarily with agricultural products and explain why.
5. List and explain how the four factors to be considered in planning a production system are interrelated.
6. Identify the steps used by successful managers in managing risks under various economic conditions.
7. Prepare a plan showing the continuous production process for a product of the student's choice.
8. Prepare a plan showing the intermittent production process for an agricultural product of the student's choice.
9. Prepare a paper of not less than 500 words explaining the production plan the student has prepared, which also demonstrates his or her understanding of the four factors to be considered in planning production.
10. List and explain the four areas of concern which an agricultural business must monitor once production has begun.
11. Prepare a paper of not less than 500 words on the issue of ethics and the purchasing agent. Include issues such as quantity, quality, price, timing, and service.
12. Explain the five methods of inventory control and discuss the advantages and disadvantages of each.
13. Develop a plan for monitoring the efficiency of employees in a continuous production system.
14. Develop a plan for monitoring the efficiency of employees in an intermittent production system.
15. Apply knowledge and skills learned in this problem area to FFA or SAE programs.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Operating the Agribusiness

PROBLEMS AND QUESTIONS FOR STUDY

1. What is meant by the phrase operating a business?
2. In agribusiness, what is involved in the production process?
3. What are some major concerns when planning production?
4. What are the four methods of production?
5. What are the two types of production?
6. Why are most agribusinesses involved in intermittent production?
7. What factors should be considered when identifying a location for an agribusiness production plant?
8. When planning the size of an agribusiness production facility what factors must be considered?
9. When setting up the organization of an agribusiness production facility, what factors must be considered starting with receiving of raw materials to shipping of finished product?
10. How does one plan for the long-term continued operation of a production operation?
11. What would be some of the major issues to address when deciding how to manage risk?
12. If an agribusiness decides to expand, what decisions need to be made and how are these decisions made?
13. Once an agribusiness begins production what issues become most important to monitor?
14. Purchasing agents have many concerns to address when deciding on a supplier. What are some of these concerns?
15. Why does ethics become so important when working as a purchasing agent?
16. How do you decide when to reorder basic materials to produce a product?
17. How have computers improved the ability to maintain an accurate inventory?
18. Why is payroll the single biggest expense in any agribusiness?
19. How does an agribusiness manager monitor payroll?
20. What makes payroll and employee efficiency so difficult to monitor in an agribusiness?

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Operating the Agribusiness

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES

1. One possible way to go through this entire problem area, showing relationships between all parts, is to have each student select a product and go through the entire process of planning to set up and operate an agribusiness.
2. An alternative method to that suggested in item 1 is to have the class as a whole work on setup and operation of a business or work in two or three groups, each with a different agribusiness.
3. The instructor can show the uniqueness of different agribusinesses by describing changes, typical of the agriculture industry, that would affect the setup and operation plans the students are developing. Changes in quantity, quality, supply, location of supplies, and government programs are examples of issues that could have a major effect on plans.
4. Various methods of production can be identified by showing different products to students and asking them to go through the process involved in producing the particular product.
5. Using the transparency masters, have students go through the planning process as before, only now they will be planning for expansion and must take into consideration the risks involved.
6. At this point it may be advisable to go through various methods of decision making from the simple flip of a coin to some of the many simulated "what if" computer software programs available.
7. Once plans are developed, have students assume one of the plans has been implemented and they must now take over as purchasing agent. Draw up a list of factors to be considered to be an effective purchasing agent for the business.
8. The issue of ethics works very well when discussing purchasing agents and should be explored with regard to a purchasing agent's responsibilities.
9. The cost of maintaining large amounts of inventory can be costly to any agribusiness. Ask students to discuss ways in which these costs can be kept to a minimum and still have the necessary inventory on hand.
10. Ask class for examples of various methods of inventory control they are familiar with and discuss advantages and disadvantages of each. You may choose to use the school's inventory system as a basis.
11. It would be beneficial to visit a progressive agribusiness in your community that uses the latest computer systems to control production and inventory. If a field trip is not feasible, the visit of a guest speaker from the agribusiness would be helpful. Ask the guest speaker to talk about systems of production, inventory control, and monitoring employee efficiency.
12. Information Sheet #9 defines several types of inventory control and the key to a successful system. Have class discuss what they feel would be the key to success of any or all the systems and why they feel as they do.
13. Monitoring is another issue that the class can discuss. Monitoring of employee efficiency is especially important and at the same time difficult. Ask students how they would monitor employee efficiency and what they would do if they found a problem, keeping in mind the nature of agribusiness as compared to other businesses.
14. A visit to or a talk by an employee of a fast food business such as McDonalds would be helpful and relevant to students' understanding of time/motion studies and employee efficiency.
15. Conclude problem area with a discussion of some local agribusiness and its apparent success based on information from this problem area. It is important that students understand how relevant this problem area is to the "real world" where they will be or are already working.

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Operating the Agribusiness

REFERENCES

*1. *Agribusiness Management.* (1987). Downey, W.D., Erickson, S.P. McGraw-Hill Publishing Company, 1221 Avenue of the Americas, New York, NY 10020.

*2. *Merchandising Agricultural Products* (VAS Unit #U6027); *Motivating Workers in an Agricultural Business* (VAS Unit #U6016); *Inventory Management and Control* (VAS Unit #U6010); *Simplifying Work in an Agricultural Business* (VAS Unit #U6006). Vocational Agriculture Service, College of Agriculture, University of Illinois, 1401 S. Maryland Dr., Urbana, IL 61801. (217) 333-3871.

*3. *Nursery Management, Administration and Culture.* (1988). Davidson, H., Mechlenberg, R., Peterson, C. Prentice Hall, Englewood Cliffs, NJ 07632.

*4. *Profitable Garden Center Management.* (1982). Berninger, Louis. Reston Publishing Company, Reston, VA.

5. *Microcomputer Applications for Students of Agriculture.* (1988). Camp, W., Moore, G., Foster, R., Moore, B. Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

*Indicates highly recommended reference

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTIONAL RESOURCES

These resources are intended for use by teachers in planning and teaching the materials for this problem area and may be adapted to fit the teaching method(s) used.

INFORMATION SHEET #1 — Terms to be Defined

INFORMATION SHEET #2 — Production Planning

INFORMATION SHEET #3 — Four Methods of Production

INFORMATION SHEET #4 — Unique Characteristics of Agricultural Production

INFORMATION SHEET #5 — Planning the Production System

INFORMATION SHEET #6 — The Expansion Plan Frame

INFORMATION SHEET #7 — Probable Results

INFORMATION SHEET #8 — Production Control Processes

INFORMATION SHEET #9 — Inventory Control

INFORMATION SHEET #10 — Monitoring Inventory and Production

TRANSPARENCY MASTER #1 — Four Methods of Production

TRANSPARENCY MASTER #2 — The Expansion Plan Frame

TRANSPARENCY MASTER #3 — Probable Results

INFORMATION SHEET #1

Terms to be Defined

Operating — conducting or directing the affairs of a business.

Production — a series of activities guided by a set of procedures that result in a product or service.

Production management — the decision-making processes required to guide and support the production process.

Production planning — what is done at every level of the business before any portion of the production process begins.

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INFORMATION SHEET #2

Production Planning

Production planning is the first step in determining the way in which an agribusiness will operate. Some basic ideas have been formulated to guide any business through the production planning process. These ideas are:

1. A standardized set of procedures for the same job each time it is performed.
2. Determination of the most efficient procedures for each job through scientific comparison tests.
3. Careful screening, hiring, and training of personnel to match them with the most appropriate job.
4. A functional decision of labor that would allow each person to perform the most suitable task in the production process, with management and workers jointly devising the best system for the division of labor.

These ideas along with wage-incentive plans, efficiency studies, work schedules, time and motion studies, and concerns for health, safety, fatigue, and pollution (noise and air, etc.) have all been incorporated into the concept of production management.

INFORMATION SHEET #3

Four Methods of Production

(Refer to Transparency Master #1)

Analysis — creating many different products from one raw material.

Extraction — the removal of a raw material from its natural setting.

Fabrication — changing the form of some material through processing to make it more saleable.

Synthesis — a single product produced through the use of many raw materials.

INFORMATION SHEET #4

Unique Characteristics of Agricultural Production

Production falls under two types:

1. Continuous, which is an uninterrupted flow of raw materials through processing to a finished product.
2. Intermittent, which involves, at times, extreme variations in availability of raw material, variable rates of production, and varying output levels.

Agricultural production and the processing of agricultural products fall primarily into the second category because of the nature of the industry and its products. Agricultural products are generally quite perishable and bulky, which means they are difficult to handle, transport, store, and process. The seasonality of production as well as variability in quantity and quality also cause problems in the flow of products from raw materials through processing to consumers.

INFORMATION SHEET #5

Planning the Production System

In planning production the entire system must be examined as a whole. There are many factors which must be taken into consideration in the planning process. Some of the major factors are:

1. Location — Should the plant be located closer to the source of raw materials or the final consumer? Also to be considered are the source of labor, access to transportation, and incentives to locate at a specific place. Environmental concerns are a major factor to be considered when deciding on a location.
2. Size — Should the plant be designed to handle peak production levels and scaled back when production drops or designed to expand as production levels increase? Also of concern is the use of second and third shifts and seasonality.
3. Organization — How should the organization of the processes within the plant be set up? Is there greater need to have like processes together regardless of products produced, or should the plant be set up to handle a single product from start to finish in an assembly line fashion? The receiving, storing, and distribution of raw materials at the plant as well as the warehousing and shipment of finished goods must also be considered.
4. The future — Should the plant be designed so that expansion is easily accomplished, or will it be more important to be able to cut back due to economic factors such as a recession?

All of the above factors point directly or indirectly towards management's ability to handle risk and uncertainty. We cannot know the future but we can use training, experience, and skills to reduce the possibility of negative effects of many risks and uncertainties. The two elements that can dramatically reduce the likelihood of error or at least hold the effects to a minimum are data from the past and experience. Successful managers are able to use data combined with years of experience to go through rapid analytical thought processes and make accurate decisions. The student may or may not lack experience. Therefore, some methods of managing risk are presented in this problem area. See the problem area entitled *Planning and Organizing the Agribusiness* for decision-making skills. *Managing Entrepreneurship Opportunities in Agriculture* also includes information on planning.

INFORMATION SHEET #6

The Expansion Plan Frame
(Refer to Transparency Master #2)

This frame is designed to assist management in making a decision on expansion of the agribusiness under three different economic conditions with three different possible degrees of expansion.

The economic conditions are:

1. EC1 — the best possible "boom" period.
2. EC2 — a static situation.
3. EC3 — a recession.

The plans are:

1. P1 — the greatest expansion.
2. P2 — some expansion.
3. P3 — minor changes in business operation with very limited expansion.

The figures in the center of the frame represent the maximum profit possible under each combination of plans and conditions. An agribusiness that is certain of the economic conditions and wishes to maximize profit can select the best alternative based on this method. The problem, however, is that the degree of certainty is rarely this high. Therefore, the decisions are not this simple.

INFORMATION SHEET #7

Probable Results

(Refer to Transparency Master #3)

The probable results matrix represents the most profitable action or plan to follow given the degree of likelihood that each economic condition will occur. The degree of likelihood is determined through use of economic forecasts, professional economists, or history of the business.

By using the formulas at the bottom, it can be determined which of the three plans of action would give the greatest return based on the degree of likelihood of each economic condition occurring. It can be seen that plan one would be the most profitable. However, if, for some reason, plan one was not a viable alternative, plans two and three would have to be examined closely, as they are quite close in profitability.

In this example, the decision is being made with the idea that a great deal of certainty exists. This is not normally the case. It is assumed in the example that degrees of likelihood are known. This is also not normally the case.

Many theories have been developed which take into consideration both optimistic and pessimistic views, opportunity costs, and risk management. It is important to keep in mind that uncertainty does exist more often than not and previous data and experience are the best inputs into a decision-making process when forecasts are needed.

Decision making is a dynamic procedure and the more tools management can incorporate into the procedure, the more likely the proper decision will be made.

INFORMATION SHEET #8

Production Control Processes

Once plans are complete and the agribusiness is in operation, management must switch its attention to the control of the production process. The focus of attention in this and the following information sheets is directed into four major areas:

1. Purchasing.
2. Inventory control.
3. Monitoring inventory.
4. Monitoring production.

In this information sheet we shall consider purchasing. Products can be purchased to be processed further, for resale "as is," or used "as is" in another product. Whichever is the case for a particular agribusiness, the paramount concern is efficient purchasing.

Five factors are to be considered in making efficient purchases:

1. Quantity — Purchase in sufficient amounts so that discounts are realized, keeping in mind warehousing capabilities, production levels, and ability of suppliers to deliver on time. Also of concern is inventory on hand. But money is tied up in inventory, so the benefit of having inventory on hand must be weighed against other more profitable uses of the same money.

2. Quality — What degree of quality is required of the products purchased to maintain quality of end products? Cheaper versions of needed products are often available at a significant savings, but consideration of the end product quality is very important.

3. Price — When deciding on price, quantity and quality of supplies or raw materials to determine the "real" best price must be considered. If either is lacking, the lowest price may not be the best price. When a few cents can be saved, it can have a major impact on total costs and profits. A one percent reduction in costs with net profit at five percent of sales can mean an increase of 20 percent in profits.

4. Time — As mentioned above, purchasing in large quantities means storage; this in turn means money tied up in inventory. In addition, there are the record keeping, insurance, and space requirements which all make demands on money. So what may be gained through quantity purchases may be lost in storage and related costs over time. An additional issue that may need to be addressed is the change in demand for the finished product. In agriculture, changes in technology and government programs can quickly result in a change in demand for a product.

5. Service — Low bidders that can't deliver are of no value to an agribusiness. Penalties in contracts for delays in delivery or spreading orders out between two or more suppliers can reduce the risk of not getting supplies in a timely manner.

6. Ethics — It is important to remember that a purchasing agent or department has the opportunity to increase profits significantly. At the same time suppliers will be doing their best to sell their products, possibly including incentives in various forms to purchasing agents. *Caution* is advised. You may be sacrificing profit and/or your career for a trivial gift.

INFORMATION SHEET #9

Inventory Control

Having tremendous stocks of needed raw materials or supplies on hand may give an agribusiness a feeling of security. However, storing large quantities means tying up large amounts of funds that could be used elsewhere in a more profitable way.

The control of inventory, then, becomes an important aspect of the successful operation of an agribusiness. Of concern is:

1. When to order or reorder.
2. Predicting trends.
3. Keeping track of inventory.

Several different methods have been developed to determine when to order or reorder, most of which are designed to match the type of production system.

1. Pipe line inventories — maintaining the minimum amount on hand to meet anticipated use or sales, and to cover the time it takes from reorder to delivery.
2. Cycle or lot size inventories — ordering larger quantities but less often than with the pipe line system.
3. Buffer inventories — ordering and keeping on hand a few extra items of a product. This is done because in the "real world" things do not always run as smoothly as we would like; labor, transportation, or communications problems can result in running out of stock for a product, causing lost sales.
4. Seasonal inventories — adjusting inventories to meet the changes in demand based on the highly seasonal nature of agriculture/agribusiness. This, unfortunately, can result in the need for expensive storage space sitting idle during some seasons and overflowing at other times. This is a costly situation for any business, but one which many agribusinesses try to minimize through diversification.
5. Just-in-time — an inventory control and ordering system which, through the use of computers, can dramatically reduce the problems associated with the systems listed above. This system requires suppliers to locate close to processing or manufacturing plants. Contracts between suppliers and the processing or manufacturing plants are drawn up which specify quantity, quality, destination within the plant, and frequency of orders. As supplies or materials are used up, computers monitor the quantity remaining and when a specific level is reached automatically generate an order in the purchasing department and at the suppliers. Orders are immediately filled and delivered into the plant at the specific spot where they are to be used. No storage or warehousing is needed and because usage is predetermined the suppliers can maintain a more even production level.

All of the systems above are only as good as management's ability to predict demand and then decide when and how much to order. Predictions also help determine storage and warehousing needs. One of the best predictors of the future is the past. Past performance and a study of current economic conditions are the most common tools used to make accurate predictions.

INFORMATION SHEET #10

Monitoring Inventory and Production

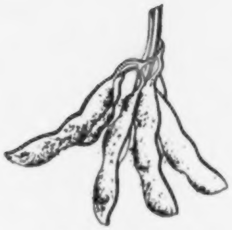
Any products stored, whether in a retail outlet or a warehouse, must be monitored so that the proper amount is always on hand. Too much means capital tied up, too little means lost sales. Computers have gone a long way in helping keep a perpetual inventory, but where computerized systems are not in use and even where they are, a periodic physical count of everything must be made. The interval between physical counts can be extended to perhaps once a year with computer systems in place. However, without computers, inventory counts may be made as often as once a month or at the end of each season.

Monitoring production is also an essential part of any agribusiness. As payroll is the single biggest expense in any business the number of employees needed to get the job done properly must be constantly monitored. In addition to the number of employees, the efficiency of those employees is also important. Decisions on the size and number of pieces of equipment must also be monitored along with employees' use of the equipment. When monitoring employees many factors come into play which are of no concern when equipment is used in place of physical labor. Many modern plants are using robotics to solve employee-related problems. The displacement of workers caused by the use of robotics creates many other issues business must deal with. These will not be addressed here but can be researched to stimulate class discussion in agriculture or social studies class.

TRANSPARENCY MASTER #1

Four Methods of Production

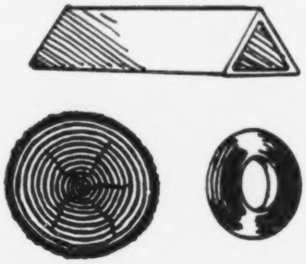
ANALYSIS
Creating many different products from one source of raw material



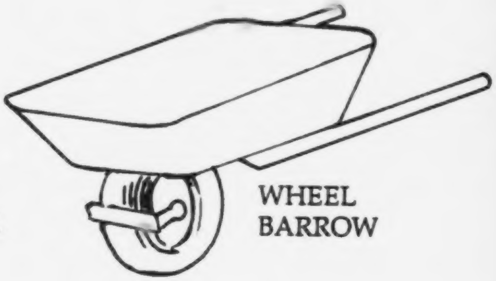
SOYBEAN

VEGETABLE OIL
PLASTICS
IMITATION FOOD PRODUCTS
GROUND MEAT, ICE CREAM, TOFU

SYNTHESIS
Creating a single product from many raw materials

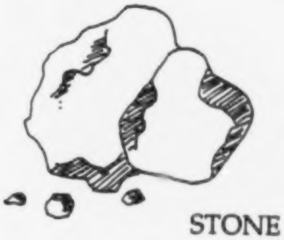


STEEL
WOOD
RUBBER

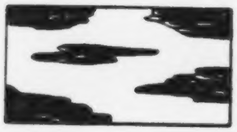


WHEEL BARROW

EXTRACTIVE
Removing a product from its natural environment

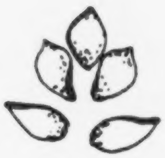


STONE

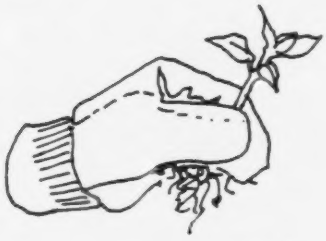


MARBLE SLABS

FABRICATION
To change the form of a material to make it saleable



SEED



BEDDING PLANTS

Reproduced from *Agribusiness Management*. Downey, W.D., Erickson, S.P. (1987). McGraw-Hill Publishing Company, 1221 Avenue of the Americas New York, NY 10020. p. 353.

TRANSPARENCY MASTER #2

The Expansion Plan Frame

Economic Conditions

Plans

	EC1	EC2	EC3
P1	14	8	3
P2	7	9	- 2
P3	4	2.5	6

TRANSPARENCY MASTER #3

Probable Results

Economic Condition	Likelihood
EC1	.47
EC2	.20
EC3	.33
	1.00 = 100%

$$EC(P1) = .47\ (14) + .20\ (8) + .33\ (3) = 9.17$$

$$EC(P2) = .47\ (7) + .20\ (9) + .33\ (-2) = 4.43$$

$$EC(P3) = .47\ (4) + .20\ (2.5) + .33\ (6) = 4.36$$

STUDENT ACTIVITIES

STUDENT WORKSHEET #1 — Floor Plan

STUDENT WORKSHEET #2 — Case Study: The Purchasing Agent

STUDENT WORKSHEET #3 — Case Study: Someone Must Go

NOTE: The case studies are designed to give students an idea of some of the problems they could face in the real world. There are no right or wrong answers. You should be looking for clear reasoning patterns. Point out to students those places in their studies where reasoning is perhaps somewhat weak.

For additional activities, teachers may refer to the "Suggested Teaching Activities and Procedures" section in the Instructor's Guide.

STUDENT WORKSHEET #1

Floor Plan

On a full sheet of poster board (22" x 26"), each student will draw a detailed floor plan for an agribusiness production plant. The product produced should be approved by the instructor. The plan should include every phase of production from receiving of raw materials or supplies, through all phases of processing, to shipping of the finished product. The floor plan must be laid out to make the most efficient use of every area with a minimum of wasted space.

A paper of no less than 500 words shall accompany the plan, explaining the plan and including a demonstration of the student's understanding of the four factors to be considered in planning a production facility.

STUDENT WORKSHEET #2

Case Study: The Purchasing Agent

You are to assume that you have just taken the position of purchasing agent for a medium-sized agribusiness in your local community. The agribusiness has decided to begin making a brand new product which requires some new raw materials. You are to locate the best possible source for the raw materials and get a contractual agreement with the supplier for a six-month trial period. You have identified and narrowed down the suppliers to two and must now decide. This is what the suppliers offer:

Supplier #1 — Raw material within the range established by your company for acceptable quality. Ability to ship raw material in quantity desired within two days after receiving order. Price is above maximum range but they are willing to discuss price if they get some guarantee beyond six months now. Service to other businesses in the community has been good but they have never done business with you before. It is also pointed out that if a minimum order is maintained each year the purchasing agent can expect a very nice gift at Christmas time.

Supplier #2 — Raw material is just slightly below the minimum range for quality established by your company. Ability to ship the same day order is received. Price is well below supplier #1 and at bottom of range established by your company, but firm. Service to other businesses in your community is good to fair but generally good. It is also pointed out that if any problems should result as a result of the raw material being slightly below what was the established range, it could be offset by lower costs.

You are to prepare a paper of not less than 500 words on what you would do and why. Be specific in your paper on which supplier you have chosen and why. You must be prepared to defend your position orally in class.

STUDENT WORKSHEET #3

Case Study: Someone Must Go

You are the new supervisor at a processing plant. Production is adequate but you observe some abuse of coffee breaks and lunch hours by several of the employees.

Employee #1 — Has a beer or two at a local eating establishment on his lunch hour. Company policy forbids this but has overlooked it until now.

Employee #2 — Is gone fifteen minutes longer than the hour allowed for lunch in addition to the regular fifteen minute break in the morning and afternoon as guaranteed by the company. When questioned about her lunch hour she explains that she has to pick up her child at school and take her to a baby sitter. She says her child is only in kindergarten and this won't happen once her daughter is in school all day next year.

Employee #3 — A young women on the job six months is very prompt, works very hard, but cannot keep up with the work. She seems to lack the physical ability to do the work, but you are not sure if there is a physical problem or if she was never properly trained. She has caused some slowdowns to occur from time to time.

Employee #4 — The owner's nephew has two half-hour breaks and an hour-and-a-half for lunch. He is very capable, has good potential, but seems to be relying on his uncle to pull him through.

Your supervisor says you must let one of these people go to reduce production costs but production must be kept at the present level or improved. What do you do?

Prepare a paper of not less than 300 words explaining what you would do and why. Be specific. You will be asked to defend your position in class orally.

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Managing Entrepreneurship Opportunities in Agriculture

RELATED PROBLEM AREAS:

1. Applying Basic Economic Principles in Agribusiness (Central Core Cluster)
2. Understanding Basic Business Organization (Central Core Cluster)
3. Planning and Organizing the Agribusiness

PREREQUISITE PROBLEM AREA(S): None

LEVEL: Preparatory

OCCUPATIONAL TASKS ADDRESSED:

Agricultural Business and Management Cluster

Duty F: Financing the Agribusiness

1. Calculate operating expenses
2. Prepare cash flow projections
3. Prepare budget
4. Calculate insurance needs

STATE GOALS FOR LEARNING:

In planning the instruction for this problem area, teachers can promote the development of several student learning objectives which are related to the State Goals for Learning in Social Sciences. These objectives are listed on the Learning Assessment Plan forms included on the following pages. Those learning objectives marked with an asterisk (*) are taken from sample lists provided by the Illinois State Board of Education.

Illinois Agricultural Core Curriculum

Agricultural Education 124 Mumford Hall 1301 W. Gregory Drive University of Illinois Urbana, IL 61801

Director: Dale A. Law, Ed.D.
Principal Investigator: Jerry D. Pepple, Ed.D.
Research Associate: Paul E. Hemp, Ed.D.

Submission Date ______________
☐ Original submission ☐ Revision
Page ____ of ____

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☐ Mathematics ☒ Social Sciences
☐ Sciences ☐ Physical Development/Health

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)
COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐
District Name
City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to understand and analyze comparative political and economic systems, with an emphasis on political and economic systems of the United States.

Contact Person: ______________
Title: ______________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Understand the meaning and importance of profit in business.					
*2. Identify the factors which affect supply and demand.					
*3. Understand the effects of competition on the producer and the consumer.					
*4. Understand how the factors of production (natural resources, labor, capital, management) affect production.					
*5. Understand the significance of three questions faced by all societies: What to produce? How to produce it? For whom to produce?					
*6. Distinguish between private ownership and collective ownership.					
*7. Compare how the "what," "how," and "for whom" decisions are made in a market economy and a command economy.					
*8. Understand why a market economy is likely to offer a greater variety of goods and services than a command economy.					

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Managing Entrepreneurship Opportunities in Agriculture

STUDENT LEARNING OBJECTIVES

Upon completion of their study of this problem area, students will be able to:

1. Identify the major differences between a command economy and a market economy.
2. Name and describe the key concepts of American enterprises.
3. Name the four types of economic resources.
4. Identify the personal characteristics of successful entrepreneurs.
5. Conduct a feasibility study on possibilities of establishing a new business enterprise.
6. Prepare a financial budget and business plan.
7. Estimate expected income and expenses for one year for a new business enterprise.
8. Apply knowledge and skills learned in this problem area to an FFA or SAE program.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Managing Entrepreneurship Opportunities in Agriculture

PROBLEMS AND QUESTIONS FOR STUDY

1. What are the advantages and disadvantages of operating and owning a business?
2. What are the characteristics of a market economy?
3. What is meant by "the profit motive"?
4. What are the four economic resources used in production?
5. How is productivity measured?
6. What is the "law of supply and demand"?
7. In theory, how is a free market supposed to function?
8. In practice, how are adjustments made to regulate or affect the free market system?
9. What is capitalism? Identify and describe other alternative economic systems.
10. Describe the type of person who is most likely to succeed as an entrepreneur.
11. Name the steps one should follow in exploring the possibilities of establishing a new business.
12. What are some sources of assistance available to entrepreneurs?
13. What are the various expenses (costs) involved in starting a new business and during the first year of operation?
14. Name three ways to become established in business.
15. How does price affect the demand for a product?
16. What happens to supply when prices increase?
17. How does competition affect the producer? The consumer?
18. Explain how the following questions are answered in a command economy and a market economy:
    a. What to produce?
    b. How to produce it?
    c. For whom to produce?
19. Why is a market economy likely to offer a greater variety of goods than a command economy?
20. Name six opportunities for entrepreneurship that are available to high school students in the local community.
21. What are some risks that a businessperson experiences in operating a business?
22. How could principles of vocational ethics be employed in (a) deciding what kind of business to start, and (b) operating a small business.
23. What is a business idea? What business ideas related to agriculture might be implemented successfully in our community?

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Managing Entrepreneurship Opportunities in Agriculture

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES

1. Begin the problem area with an interest approach which includes an overview of what is to be studied.
2. Involve class in the development of objectives and problem identification.
3. Define entrepreneurship. Have class give examples of locally owned businesses which are operated by a sole proprietor.
4. Present an overview of the command economy and the market economy including the following:
   a. Definition of each.
   b. Countries where each type is found.
   c. How and why economies differ from the pure definition.
5. Present key concepts of American enterprise and discuss the meaning and importance of these concepts with the class.
6. Review the four types of economic resources. Have class explain how these factors are used in different types of businesses (service business, farming, product sales, etc.).
7. Have class identify from their own experiences or observations those personal characteristics which are needed for success in (a) self-employment, and (b) working for an employer.
8. Discuss supply and demand. Have students complete Student Worksheets #1 and #2 on the demand curve and supply curve.
9. Have students complete the expected income and expense worksheet for a business of their choice (nonfarm enterprise, crop, or livestock project).
10. Divide class into groups or pairs and assign each group or pair responsibilities for developing a business plan.
11. Utilize appropriate sections of SAE record books to teach about budgets and business plans.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Managing Entrepreneurship Opportunities in Agriculture

REFERENCES

INSTRUCTOR'S NOTES AND REFERENCES

1. *Doin' Business: User's Handbook.* (1980). Downing and Hirsch. The Institute for Constructive Capitalism, The University of Texas at Austin.

2. *Risks and Rewards of Entrepreneurship.* (1988). Ashmore and others. Changing Times Education Service, EMC Publishing, 300 York Avenue, St. Paul, MN 55101.

3. "Financial Independence," *Mother Earth News.* (1988). (Special series published for Nissan Motor Corporation; articles describing personal experiences of entrepreneurs engaged in 29 different small businesses). Mother Earth News, Inc., 80 Fifth Avenue, New York, NY 10011.

4. *Getting Down to Business — What's It All About*? (1981). McFarlane, Carolyn. The Vocational Studies Center, University of Wisconsin-Madison, 265 Educational Sciences Building, 1025 W. Johnson Street, Madison, WI 53706.

*5. *Agriculture in Our Lives.* (1984). Krebs, A. H. Interstate Publishers, Inc., P. O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

*6. *The Creative Young Entrepreneur.* (1988). Doster, Hamilton, Connely. Three Entrepreneurs, 111 Circle Lane, West Lafayette, IN.

*7. *Agribusiness Management.* (1987). Downey, W.D., Erickson, S.P. McGraw/Hill, 1221 Avenue of the Americas, New York, NY 10124-0025.

*Indicates highly recommended references.

INSTRUCTIONAL RESOURCES

These resources are intended for use by teachers in planning and teaching the materials for this problem area and may be adapted to fit the teaching method(s) used.

INFORMATION SHEET #1 — Terms to be Defined

INFORMATION SHEET #2 — Advantages and Disadvantages of Self-Employment

INFORMATION SHEET #3 — Characteristics of a Successful Entrepreneur

INFORMATION SHEET #4 — General Characteristics of Economic Systems

INFORMATION SHEET #5 — Key Concepts of American Enterprise

INFORMATION SHEET #6 — Steps in Developing a Business Plan

INFORMATION SHEET #7 — Financial Budget and Plan

INFORMATION SHEET #8 — Examples of Entrepreneurship Projects

INFORMATION SHEET #9 — Cash Flow

TRANSPARENCY MASTER #1 — Four Types of Economic Resources

TRANSPARENCY MASTER #2 — Three Basic Questions to Answer

INFORMATION SHEET #1

Terms to be Defined

Capitalism — an economic system in which all or most of the factors of production and distribution are privately owned and operated for profit.

Cash flow — a budget that reflects the timing of expenses and income.

Command economy — an economic system in which most of the means of production and distribution are regulated or controlled by a centralized decision-making structure.

Competition — a situation where no single seller or buyer can unduly influence the price of a particular product or service.

Demand — willingness to buy.

Demand curve — a curve which shows the amount of a product which buyers are willing to buy at specified prices.

Entrepreneur — one who organizes, manages, and assumes the risk of a business.

Entrepreneurship — assuming the risks of owning your own business.

Free enterprise — freedom to own and operate a business, to invest capital, and to earn a profit.

Loss — the amount by which business expenses exceed income.

Market economy — an economic system based on private ownership of property and free enterprise principles.

Profit — return received on a business undertaking after all operating expenses have been met.

Profit and loss — a method of measuring the results of business transactions.

Productivity — amount of output produced by a unit of input during a specific period of time.

Supply — the amount of goods or services that producers offer for sale at a given time.

Supply curve — a curve which shows the amount of a product which producers are willing to sell at specified prices.

INFORMATION SHEET #2

Advantages and Disadvantages of Self-Employment

Advantages

1. Can be your own boss — independence.
2. Rewards can increase if business is successful.
3. Can capitalize on your own creativity and resourcefulness.
4. Offers one a chance for pride and self-satisfaction.
5. Will have a variety of tasks to perform.
6. Can set one's own working hours and schedule.

Disadvantages

1. Have to take risks.
2. Require a capital investment.
3. Uncertain financial returns.
4. Responsible for compliance with government programs and regulations.
5. May require more than 40 hours of work per week.

INFORMATION SHEET #3

Characteristics of a Successful Entrepreneur

Successful entrepreneurs seem to exhibit certain personality characteristics which may not apply to some employed workers. These characteristics are not absolutely essential for success, but they do indicate the type of person who is most likely to succeed as an entrepreneur.

1. Independent — likes to work in an unstructured situation, wants to choose actions of his or her choice and not be obligated to follow dictates of others.
2. Willing to assume risk — takes a chance on a new product or activity, does not restrict actions to traditional patterns if alternative procedures have promise of success.
3. Creative — can think of new ways to solve problems, has good business ideas, can design or make new things.
4. Resourceful — can come up with new ways to solve problems or achieve goals, can handle unexpected situations successfully.
5. Self-confident — has favorable self-image, believes in his or her ability to succeed.
6. Responsible — is accountable for own actions and decisions, willing to assume the blame for failure.
7. Determined — keeps trying until job is done or goal is reached, does not give up.
8. Efficient — uses time and resources wisely, does not waste time or effort, can maximize production while controlling input.
9. Goal-oriented — sets goals for the business and develops and executes plan to achieve goals.
10. Open-minded — is willing to listen to new ideas and concepts, willing to improve or change, not afraid to ask for advice.
11. Leader — likes people and gets along with them, can get others to follow, can supervise others and relate to customers and clients.

INFORMATION SHEET #4

General Characteristics of Economic Systems

Introduction

This information sheet has been prepared to provide the teacher a brief overview of two types of economic systems. It is not intended as an informational resource for a thorough coverage of this topic. References listed in the Instructor's Guide and other materials and resources selected by the teacher or school librarian should be studied by the student for an in-depth investigation of this topic.

Four Types of Economic Resources

Four types of economic resources are used in all economic systems to produce goods and services to satisfy human needs. These four types are as follows:

1. Natural resources — land or material supplied by land such as petroleum, water, timber, and minerals.
2. Human resources — the physical labor needed to produce a product or provide a service.
3. Capital resources — money used to purchase buildings, equipment, and supplies that are needed for production.
4. Technological resources — organizing ability and administrative expertise needed to operate an economic system or business successfully (sometimes referred to as management).

Three Basic Questions to be Answered

In order for an economic system to function smoothly and effectively, three basic questions must be considered and answered. They are as follows:

1. What, and how much, will be produced? Answers to this question may be provided by the consumer, the producer, or the government depending on the type of economic system in place.
2. How will production be accomplished? Since the factors of production are normally in short supply, decisions must be made about how these factors are combined to produce the necessary products and services.
3. Who will receive the goods and services? This question may be answered by suppliers, producers, or consumers. Factors which affect the distribution of products include buyers' taste, prices charged, and ability of buyers to pay the purchase price.

The Command Economy

A command economy is characterized by centralized decision making of the three basic questions that must be answered. The government or a group appointed by the government decides what is to be produced and who will receive the outputs of production. In a command economy, a general economic plan which includes answers to the three basic questions is developed and enforced by government planners.

The Market Economy

A market economy is based on interactions in the marketplace. In other words, buyers and sellers get together and decide on prices or how goods and services are to be exchanged. Obviously, in a large market economy the decision-making process is considerably more complicated and certain restraints and incentives are commonly applied through government regulations and control.

In practice, most countries do not have either a command economy or a market economy in pure form. Most economies are more accurately described as "mixed economies"; however, the mixed economy of the United States more closely resembles the market economy than the command economy.

INFORMATION SHEET #5

Key Concepts of American Enterprise

1. Free enterprise — Individuals can own and operate their own business. Freedom of enterprise means people can invest in productive enterprises, earn a profit, and reinvest profits in the business. However, some business enterprises are owned and controlled by the government, and all private enterprises are subject to certain government rules and regulations.

2. Freedom of individual choice — This concept applies to all citizens. For consumers, it means the freedom to buy goods and services of their choice and the freedom to buy from the seller of their choice. In addition, people are free to choose the occupations they want to follow and to become established in those occupations within the limitations of their abilities and resources.

3. Principle of supply and demand — Consumers establish the demand of a specific product based on their wants and their ability to pay the selling price. Producers affect the supply by responding to the demands of consumers. In practice, the supply and demand principle is often influenced by government actions which tend to influence or control prices, affect the supply, or change the demand.

4. Competition — In the market setting, competition makes it possible for potential buyers to choose from a variety of products at a variety of prices. Consumers can exercise their freedom of choice to select and buy the product or service which best meets their wants and matches their ability to pay. Competition for the products means that producers must compete with one another to supply a product or service that will sell. Competition is not restricted to the marketplace. It operates as a form of human behavior in almost every phase of our lives.

5. Profit and loss — In the business world, success is often measured by profits, and failures can result from large and continuous losses. The possibility of earning a profit is the main incentive for starting and continuing a business enterprise.

6. Productivity — Productivity, which is the amount of output resulting from a unit of input during a specific period of time, can be calculated for all four factors of production. However, most people tend to think of productivity as the amount obtained from the input of labor. Obviously, productivity has considerable influence on the cost of doing business and the cost per unit of products and services produced.

INFORMATION SHEET #6

Steps in Developing a Business Plan

Business plan — A plan for starting a business that includes the time, costs, returns, and capital required to achieve success. It includes:

1. An idea — Something you want to develop or do.
2. Your competition —Is anyone else doing it? Can you do it better or cheaper?
3. Market — Who will buy your product or service? How long will the market last?
4. Resources needed — What resources (material, human, capital, and technological) are needed to operate the business? Can you acquire these resources and finance them?
5. Business regulations — What are the federal, state, and local regulations which will affect your business? Consider waste disposal, zoning restrictions, insurance requirements, labor laws, tax obligations, environmental regulations, and liability problems.
6. A marketing plan — Who will buy your product or service? Do you need to create a demand (advertise)? Will sales be uniform throughout the year?
7. Location — Consider public access, visibility, required floor space, cost of rent or ownership, and possibility of expansion.
8. Employees — Do you need to hire extra help? What qualifications should they have? What salary and benefits will you offer?
9. Management — Who will manage the business?
10. Financial plan — Include the following: (a) income statement or profit and loss statement, (b) balance sheet — assets and liabilities, and (c) cash flow statement — amount of expected income and estimated expenses each month for the first year of operation.

INFORMATION SHEET #7

Financial Budget and Plan

START-UP EXPENSES	
Equipment	$2,000
Supplies	200
Deposit on rented property	150
Repairs and remodeling costs	350
Legal fees	125
Other	75
TOTAL START-UP EXPENSES	$2900
OPERATING EXPENSES (first 3 months)	
Salaries	$600
Rent	450
Utilities	250
Advertising	120
Supplies	180
TOTAL OPERATING EXPENSES (first 3 months)	$1600
Total for Start-up and First 3 Months	$4500
Money on Hand	$2500
Amount to be Borrowed	$2000

INFORMATION SHEET #8

Examples of Entrepreneurship Projects

1. Pet and plant care — High school students can start a pet and plant care service with very little investment of capital. The main resource needed to conduct such a business is labor. A pet and plant care business is especially suited for summer months when families take vacations and need someone to care for pets, house plants, or outdoor plants while they are away from home.

2. Beekeeping — Keeping bees and selling honey is a small business that can vary in size and investment depending on the amount of capital and time available. One vocational agriculture student in western Illinois estimated that his start-up cost for one hive of bees was $200. In addition to capital investment, beekeeping requires a good knowledge of bees and skill in handling them.

3. U-Pick fruit and vegetable operations — In recent years, customer interest in picking strawberries, raspberries, and other fruits and vegetables has increased dramatically. These operations can be started on a small scale, but they can be expanded to a full-time business at least during the growing season. Students interested in investigating opportunities in this area can obtain information from the following Horticulture Fact Sheets from the Department of Horticulture at the University of Illinois, Urbana-Champaign:

   a. Liability and Insurance for U-Pick Operations (HM-2-79) by Donald L. Uchtmann.
   b. Pick-Your-Own Marketing of Fruits and Vegetables (HM-1-79) by J. W. Courter.
   c. The Strawberry Enterprise (FR-10-86) by C. C. Doll and J. W. Courter.
   d. Publications About Vegetables Crop Production (VC-12-80, Revised 4-86) by J. M. Gerber and J. W. Courter.

4. Small engine repair — Small engine repair and service is an example of a business that can be started on a small scale, expanded as demand increases, and broadened to include the selling of parts, supplies, and equipment, or servicing small tools and equipment in addition to engines.

   The requirements for starting a small engine repair service include the following:

   a. Knowledge and experience in servicing and repairing different types of small engines.
   b. A shop where work can be performed on a year-round schedule.
   c. Small investment in tools and parts.

5. Lawn maintenance service — One of the easiest small businesses for high school students to start is the care and maintenance of lawns and landscape maintenance. Capital investment includes mowing and other equipment and tools necessary for mowing, trimming, edging, and pruning. As the business expands, entrepreneurs will probably need to purchase larger units and trucks or trailers to transport equipment. Another way to expand the business to a year-round operation would be to add snow removal services as a winter project.

6. Crop production projects — Farmers are entrepreneurs engaged in the production of crops and livestock for the domestic and international markets. Crop production projects have been conducted by high school vocational agriculture students as part of their supervised occupations experience programs. These projects qualify as entrepreneurship projects when the students have ownership and managerial control. Many young farmers have become full-time entrepreneurs by starting with small crop production projects during the high school years. Examples of crop production projects popular in Illinois include corn, soybeans, small grains, vegetables, and specialty crops.

Examples of Entrepreneurship Projects (cont'd.)

7. Livestock projects — The most common and probably the most popular type of entrepreneurship project conducted by vocational agriculture students in Illinois is livestock production. Students can begin with a minimum investment of money needed to purchase animals and, in most cases, can rent or have access to buildings and equipment on the home farm. Entrepreneurship skills learned by students who conduct these projects are one of the most valuable learning outcomes of SAE programs. Examples of livestock projects common in Illinois include swine, beef cattle, sheep, dairy, poultry, and specialty animals.

8. FFA group projects — Entrepreneurial projects can also be conducted on a group basis in a school setting. Examples of these projects are farming a plot or small acreage, raising livestock, and growing greenhouse plants. In conducting these group projects students can simulate some of the business experiences involved in the operation of an agribusiness firm. For example, the small business can be organized as a corporation or cooperative. Shares of stock may be issued or purchased by students and a board of directors can be elected to make the necessary management decisions. These group projects often provide valuable learning opportunities to students who do not have the capital or other resources to invest in a sole proprietorship. For other students, group projects provide learning experiences in the corporation and/or cooperative way of doing business.

INFORMATION SHEET #9

Cash Flow

A cash flow statement will reflect the projected or actual flow of expenses and income. A business can be profitable for a period of time, yet have "cash flow problems" at certain times of the year. These problems may result from seasonal changes in sales, unexpected expense charges, or credit problems.

The main reason for keeping track of the cash in a business is to know whether or not there is enough money on hand to pay the bills each month. Projected cash flow for each month of the year should be figured to alert the owner to possible cash shortfalls which must be met. To handle these projected shortfalls, the business operator may need to:

1. cut down on purchases.
2. buy items on credit.
3. defer payment of owner's salary.
4. work harder on getting customers to pay their bills.

It is especially important to have a cash flow projected for a new business. Many small businesses fail because the income and cash on hand is not sufficient to pay expenses. It is not unusual for new businesses to have cash flow problems during the first year or years of operation. When the cash flow is such that salaries, rent, and other bills cannot be paid, the owner must borrow capital or face liquidation.

On the other hand, cash flow can be a positive situation. For any given month or season, income may exceed expenses. When this happens, cash is accumulated and the business manager must decide how to invest or save excess money wisely.

Cash flow and inventory are closely related. Large inventories mean that capital is tied up for a period of time. Business operators must control the size of their inventory in order to maintain a desirable cash flow.

Another factor which influences cash flow is credit. Offering credit to customers delays the flow of cash into the business. The use of credit to purchase merchandise or equipment may help the business operator maintain a positive cash balance in the business.

In summary, the cash flow sheet is a valuable management tool. Management and coordination are the means of controlling cash flow. The projected cash flow should be figured before a new business is started. Actual cash flow records should be kept and studied in established businesses to maximize profits and prevent unexpected cash flow problems.

TRANSPARENCY MASTER #2

Three Basic Questions to Answer

1. What, and how much, will be produced?

2. How will production be accomplished?

3. Who will receive the goods and services?

STUDENT ACTIVITIES

STUDENT WORKSHEET #1 — Demand Curve

STUDENT WORKSHEET #2 — Supply Curve

STUDENT WORKSHEET #3 — Expected Income and Expenses

STUDENT WORKSHEET #4 — Crop Budget—Expected Income and Expenses

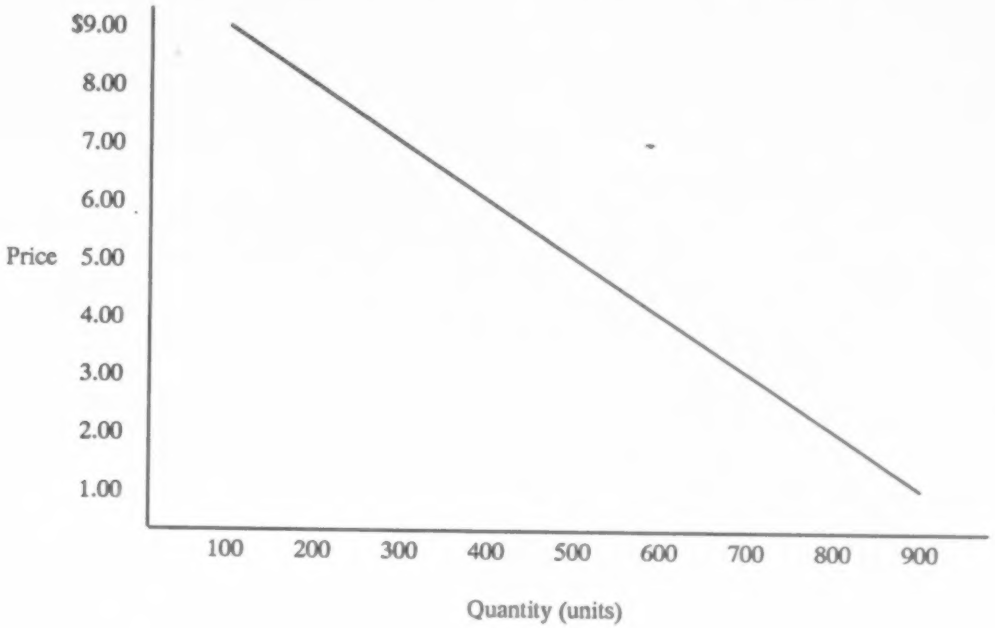
STUDENT WORKSHEET #5 — Livestock Budget—Expected Income and Expenses

For additional activities, teachers may refer to the "Suggested Teaching Activities and Procedures" section in the Instructor's Guide.

STUDENT WORKSHEET #1

Demand Curve

The diagram below illustrates the relationship that exists between the price of a product and its demand.



1. The amount or quantity of an agricultural product that would be purchased at a given price and at a specific time and place is called ______________ .

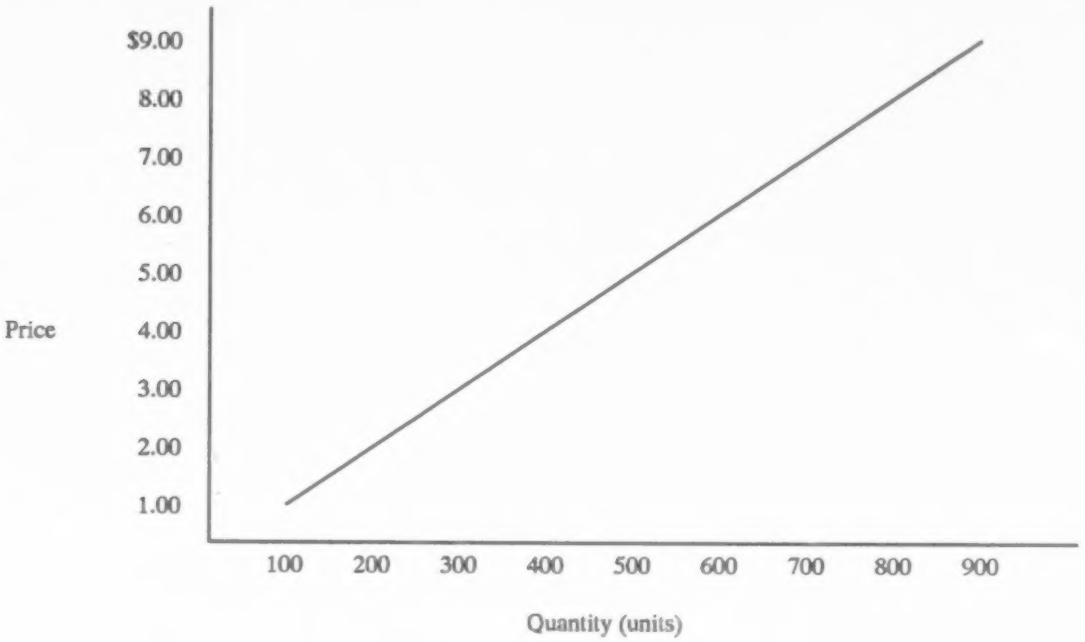
2. As the price of an agricultural product increases, the demand ______________ .

3. According to the diagram above, how many units of an agricultural product will be in demand if the price is $3.00? ___________

STUDENT WORKSHEET #2

Supply Curve

The diagram below is a simplified example showing the relationship between the price and supply of a product.



1. The amount or quantity of an agricultural product available for sale at a given price and at a specific place and time is called ____________.
2. As the price of an agricultural product increases, the supply ____________.
3. How many units of an agricultural product would be purchased at a price of $8.00 according to the diagram above? ____________

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STUDENT WORKSHEET #3

Expected Income and Expenses

Select a service business such as lawn maintenance and care as a possible entrepreneurial project. Calculate the expected income and estimated expenses for one year using the form outlined below.

Expected Income

1. Mowing lawns
   a. Number of lawns to be mowed. (Multiply number of lawns times number of mowings per year.) ______
   b. Average expected return per mowing ______
   c. Income (a x b) ______
2. Fertilizer applications
   a. Number of applications ______
   b. Amount charged per application ______
   c. Income (a x b) ______
3. Miscellaneous lawn services performed for hourly wages (edging, weeding, watering, pruning, and raking)
   a. Estimated hours of work ______
   b. Charge per hour ______
   c. Income (a x b) ______

Total Expected Income (add 1c, 2c, and 3c) ______

Estimated Expenses

1. Depreciation of mowers. Estimate value of mowers at beginning of year and end of year. Difference is depreciation. ______
2. Depreciation of other equipment ______
3. Gasoline and oil ______
4. Repairs ______
5. Fertilizer costs ______
6. Labor costs ______
7. Other ______
   ______

Total Estimated Expenses (add lines 1-7) ______

Profit (Total Expected Income - Total Estimated Expenses) ______

Labor and Management Wage (Add profit and charge for operator's or one's own labor) ______

STUDENT WORKSHEET #4

Crop Budget — Expected Income and Expenses

This worksheet is taken from *Records of My Supervised Experience Program* available from Interstate Publishers, Danville, Illinois, 61834. The crop budget section is reproduced here as a student worksheet.

Expected Income or Credits:	Quantity	Value	
1. Crops to be sold or used	______	______	
2. Crops in ending inventory	______	______	
3. Total income or credits	______	______	$ ______
Expected Expenses or Debits:			
4. Crops to be purchased (or received as gifts)	______	______	
5. Crops in beginning inventory	______	______	
6. Machinery, power, and/equipment		______	
7. Seed $____, fertilizer $____, pesticides $____		______	
8. Labor: (total) _____ hours at $_____ per hour		______	
9. Land: taxes $_____ (if owned); rent $_____ per acre or ______ % of crop		______	
10. Interest: _____ % on $ ______ (beginning investment)		______	
11. Miscellaneous: (building, drying, insurance, etc.)		______	
12. Total expenses or debits (lines 4 through 11)			$ ______
13. Profits: (expected income minus expenses; line 3 minus line 12)			$ ______

STUDENT WORKSHEET #5

Livestock Budget—Expected Income and Expenses

This worksheet is taken from *Records of My Supervised Experience Program* available from Interstate Publishers, Danville, Illinois, 61834. The livestock budget section is reproduced here as a student worksheet.

Expected Income or Credits:	Number	Weight	Value	
1. Animals to be sold or butchered for home use	______	______	$ ______	
2. Animals in ending inventory (end of year)	______	______	______	
3. Livestock products to be sold or consumed*	______	______	______	
4. Total income or credits (lines 1, 2, and 3)				$______
Expected Income or Debits:				
5. Animals to be purchased (or received as gifts)	______	______	______	
6. Animals in beginning inventory (first of year)	______	______	______	

Feed:	Value of feed:	
7. Grain: ______ bu. corn at $ ______	$______	
8. ______ bu. oats at $ ______		
9. Protein supplement: ______ lb. at $ ______ per cwt.	______	
10. Hay: ______ ton at $______ per ton	______	
11. Pasture: ______ acres at $ ______ per acre	______	
12. Other feed: ______________________	______	
13. Total feed		$______
14. Machinery, power, and equipment		______
15. Buildings		______
16. Labor: (total) ______ hours at $______ per hour	______	
17. Interest: ______% on $______ (beginning of the year investment)	______	
18. Other livestock expense: (veterinary, registration, insurance, etc.)	______	
19. Total expenses or debits (lines 5 through 18)		$______
20. Profits (expected income less expected expenses: line 4 minus line 19)		______

*Livestock products are dairy products, eggs, or wool.

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Identifying Career Opportunities in Agribusiness Management

RELATED PROBLEM AREAS:

1. Identifying Careers in Agriculture/Horticulture (Central Core Cluster)
2. Identifying and Using Agricultural Organizations, Agencies, and Sources of Information About Agriculture (Central Core Cluster)
3. Gaining Employment in an Agricultural Occupation (Central Core Cluster)
4. Managing Entrepreneurship Opportunities in Agriculture
5. Identifying Career Opportunities in Animal Science
6. Identifying Career Opportunities in Plant and Soil Science
7. Identifying Career Opportunities in Food Service
8. Identifying Career Opportunities in Agricultural Engineering and Mechanization

PREREQUISITE PROBLEM AREA(S):

It is strongly recommended that students complete all problem areas under the unit: "Agribusiness Operations and Management" before completing this problem area.

LEVEL: Preparatory

OCCUPATIONAL TASKS ADDRESSED: None

STATE GOALS FOR LEARNING

In planning the instruction for this problem area, teachers can promote the development of several student learning objectives which are related to the State Goals for Learning in Language Arts and Social Sciences. These objectives are listed on the Learning Assessment Plan forms included on the following page(s). Those learning objectives marked with an asterisk (*) are taken from the sample lists provided by the Illinois State Board of Education.

Illinois Agricultural Core Curriculum

Agricultural Education 124 Mumford Hall 1301 W. Gregory Drive University of Illinois Urbana, IL 61801

Director: Dale A. Law, Ed.D.
Principal Investigator: Jerry D. Pepple, Ed.D.
Research Assistant: James K. Shinn

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Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date ____________
☐ Original submission ☐ Revision
Page ____ of ____

(Affix label or complete district information.)

COUNTY	DISTRICT	ESC

District Name

City

I. LEARNING AREA *(check one)*

☐ Language Arts ☐ Fine Arts
☐ Mathematics ☒ Social Sciences
☐ Sciences ☐ Physical Development/Health

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to apply the skills and knowledge gained in the social sciences to decision making in life situations

Contact Person: ____________
Title: ____________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Distinguish between responsibilities of employers and workers in the work place.					
2. Identify, through the use of a matrix developed in class, major job charactersistics that separate employees from agribusiness managers.					

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LEARNING ASSESSMENT PLAN

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Submission Date ____________
☐ **Original submission** ☐ **Revision**
Page ____ of ____

I. LEARNING AREA *(check one)*
☒ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☐ Sciences ☐ Physical Development/Health

(Affix label or complete district information.)
COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐
District Name
City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to read, comprehend, interpret, evaluate, and use written material.

Contact Person: ____________
Title: ____________
Phone: ( )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. List and explain the four major paths people follow to become agribusiness managers, giving both advantages and disadvantages of each path.					
2. Conduct a search of various materials on career opportunities in agribusiness management to identify various sources and uses of these materials.					
3. Demonstrate understanding of the sources and application of various sources of information available on management opportunties.					

ISBE 41-78 (1/88)

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Identifying Career Opportunities in Agribusiness Management

STUDENT LEARNING OBJECTIVES

Upon completion of their study of this problem area, students will be able to:

1. Identify, through the use of a matrix developed in class, major job characteristics that separate employees from agribusiness managers.
2. List and explain on paper and through small group interaction, one of the four major paths people follow to become agribusiness managers giving both advantages and disadvantages of this path.
3. Identify and become familiar with the various sources of information available in agribusiness by developing a list of at least three sources, giving their content and application to a job search.
4. Demonstrate understanding of the available sources of information on management opportunities in agribusiness, and the application of those sources, by developing a paper of at least five hundred words listing all the steps to be followed, and their possible outcomes, for locating a career opportunity in a specific agribusiness management position.

INSTRUCTOR'S NOTES AND REFERENCES

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INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Identifying Career Opportunities in Agribusiness Management

PROBLEMS AND QUESTIONS FOR STUDY	INSTRUCTOR'S NOTES AND REFERENCES
1. How does being a manager differ from being an employee?	
2. What are the basic duties and responsibilities of an agribusiness manager?	
3. What are the four main paths generally followed in becoming an agribusiness manager?	
4. What are the major advantages and disadvantages of each of the four paths to becoming an agribusiness manager?	
5. What are the sources of information available locally to assist students in identifying career opportunities in agribusiness management?	
6. Select a specific agribusiness and conduct a search of career opportunities in management of that business. Answer the following questions: a. What are the educational requirements? b. What are the prospects for further employment? c. What are the duties and responsibilities of the specific job? d. What are the working conditions? e. What is the salary range? f. Why did students select this particular agribusiness management career?	

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Identifying Career Opportunities in Agribusiness Management

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES

1. Begin the problem area by getting students to define the term management through class discussion. Be sure to reach a concensus.

2. Follow up on the concensus by developing a matrix which illustrates the differences in duties and responsibilities between employees of an agribusiness and management. Have students complete the matrix by filling in the cells through class discussion.

3. Through use of a transparency construct a visual aid to assist in discussion of the four main paths to be followed in becoming an agribusiness manager.

4. Divide class into four groups, or more if additional paths to management are suggested by the class, and assign each group a path to examine. The groups should identify, in writing, the path and list, after group discussion, advantages and disadvantages of following that path.

5. Using papers developed by small groups enhance visual aid on four main paths to agribusiness management by adding major advantages and disadvantages of each path to the transparency.

6. It is recommended at this time that someone knowledgeable in career guidance and/or counseling take the students through a step-by-step procedure used to research a specific career in agribusiness management. Urge the speaker to make remarks about or show materials that your school has available for such a search, as well as to instruct the class on how to use the resources.

7. It is strongly recommended that a respected agribusiness manager of your local agribusiness community give a talk, followed by a question and answer period, on the topic, "What does it mean to be an Agribusiness Manager?" Ideally, this should be done at the manager's agribusiness.

8. Have students select a specific agribusiness and conduct a search of career opportunities in management of that agribusiness. As a result of their search students should submit, in writing, a report which answers the following questions:
   a. What is the specific agribusiness?
   b. What are the educational requirements for a management career in this agribusiness?
   c. What are the prospects for future development?
   d. What are the duties and responsibilities of the specific career?
   e. What are the working conditions? Have students include here both environmental as well as social conditions.
   f. What is the salary range?
   g. Why did students select this particular agribusiness management career?

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Identifying Career Opportunities in Agribusiness Management

REFERENCES

1. *Careers in Agribusiness and Industry.* (1980). Stone, A.A., Stone, M.L., Gulvin, H.E. Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

*2. *Handbook of Agricultural Occupations.* (1985). Hooker, N.K. Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

3. *Essential Aspects of Career Planning and Development.* (1977). Atherton, J.C., Mumphrey, A. Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

*4. *Exploring Career Opportunities in Agriculture* (Subject Matter Unit #1050). Instructional Materials Service, Texas A & M University, P.O. Box 2588, College Station, TX 77843-2588.

*Indicates highly recommended reference

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTIONAL RESOURCES

These resources are intended for use by teachers in planning and teaching the materials for this problem area and may be adapted to fit the teaching method(s) used.

INFORMATION SHEET #1 — Terms to be Defined

INFORMATION SHEET #2 — Advantages and Disadvantages of the Four Paths to Agribusiness Management

TRANSPARENCY MASTER #1 — Management is: (with discussion guide)

TRANSPARENCY MASTER #2 — Four Common Paths to Management (with discussion guide)

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INFORMATION SHEET #1

Terms to be Defined

Entrepreneur — one who organizes, manages, and assumes the risk of a business.

Management — the act, art, or manner of managing, or handling, controlling, directing, etc.

Working conditions, environmental — those conditions which would have a direct impact on one or more of the five senses and physical well-being of the individual.

Working conditions, social — those factors, both at work and in the community, which have an impact on the attitudes, beliefs, ethics, and life style of the agribusiness manager. There are both positive and negative factors which may need to be discussed.

INFORMATION SHEET #2

Advantages and Disadvantages of the Four Paths to Agribusiness Management

	Advantages	Disadvantages
High School Graduate:	1. Begins work immediately. 2. Works way up through business, knows every aspect well. 3. Needs to invest little or no money.	1. Lacks formal management training. 2. Invests much time on the job before managing. 3. Relies on others to provide opportunities at every level of business. 4. May be limited as to level of advancement permitted. 5. May have to return to school, while working, for additional education. 6. Has extremely limited opportunities to start at management level.
Community/Junior College Graduate:	1. Has some formal management training and experience. 2. Works way up through business spending less time at some levels. 3. Knows all aspects of business well. 4. May start at entry level. 5. Needs to invest little or no money. 6. May start as management trainee, mid-management, or management. 7. Generally receives higher salary or wages.	1. Lacks a formal education for specific career in management. 2. Invests more time before managing than with university level education. 3. Relies somewhat on others for opportunities. 4. May be limited as to level of advancement permitted. 5. May have to return to school for additional education.
University Graduate:	1. Has significant formal education in management. 2. Is generally hired at management level or as management trainee. 3. Generally receives higher wages or salary. 4. Needs to invest little or no money. 5. Is generally not limited as to level of advancement. 6. Relies less on others for opportunities.	1. May lack practical experience. 2. May have to work at all levels for short periods of time to gain practical experience.
Entrepreneur or Partner:	1. Becomes manager immediately. 2. Controls all phases of the business. 3. Receives great rewards if business is successful. 4. Can capitalize on his or her own creativity and resourcefulness. 5. Will have a variety of tasks to perform. 6. Can set own working hours and schedule.	1. May need to make large capital investment. 2. Takes high risk. 3. Faces uncertain financial returns. 4. Is responsible for every aspect of the business. 5. May be required to work more than 40 hours per week.

NOTE: This is by no means a complete list and items should be added or deleted as the instructor deems necessary.

TRANSPARENCY MASTER #1

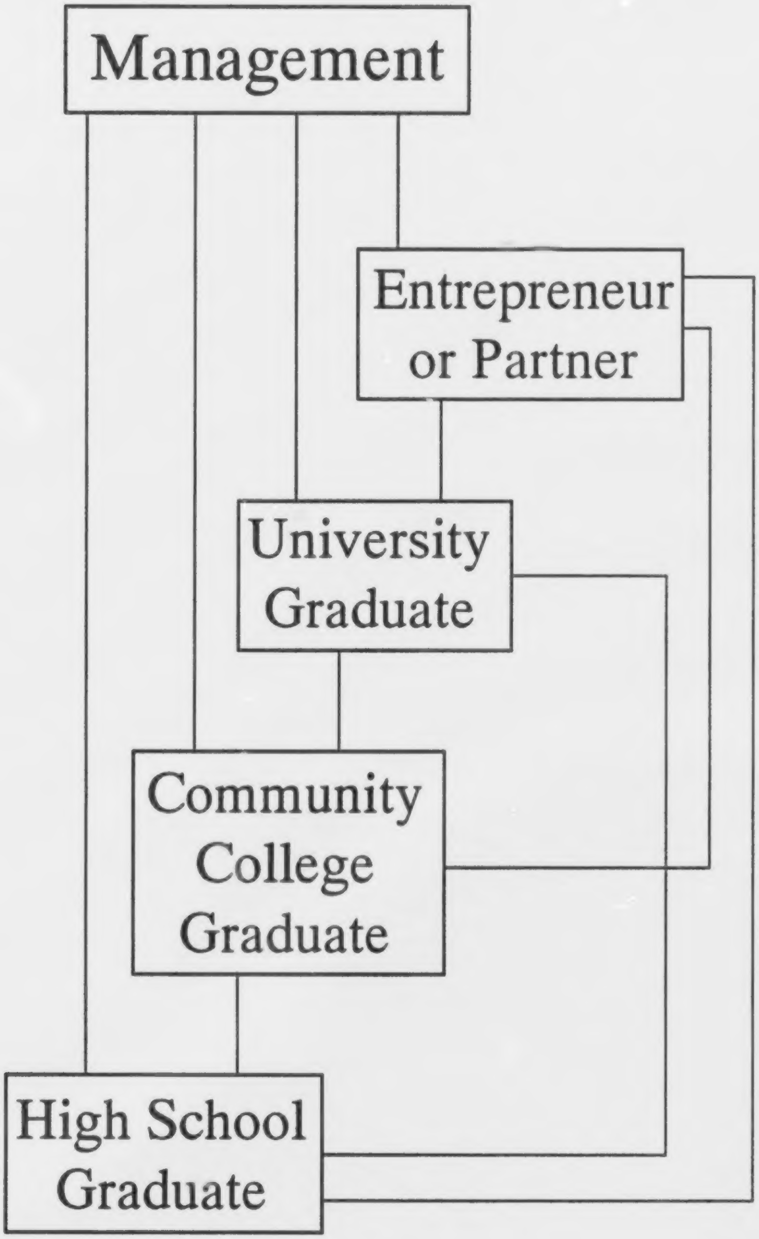
Management is:

General Employee	Agribusiness Manager

(Duties and Responsibilities)

TRANSPARENCY MASTER #2

Four Common Paths to Management



Management

Entrepreneur or Partner

University Graduate

Community College Graduate

High School Graduate

TRANSPARENCY MASTER DISCUSSION GUIDES

Transparency Master #1

	General Employee	Agribusiness Manager
1.	Generally works regular hours.	Works as needed.
2.	Is responsible for own actions.	Is responsible for actions of all employees.
3.	Has specific tasks to perform.	Has wide ranging tasks to perform.
4.	Has daily tasks often similar.	Has tasks which vary as to type and length of time to perform them.
5.	Needs to have little concern for rules and regulations outside of own area.	Needs to have great concern for rules and regulations in all areas as well as government imposed regulations.
6.	Has much freedom in personal behavior outside of work.	Needs to have concern for image portrayed at all times.
7.	Generally needs few interpersonal skills.	Generally has great need for interpersonal skills.
8.	Generally needs minimal skills in reading, writing, and mathematics.	Generally needs higher level skills in reading, writing, and mathematics.
9.	Might be helped by having some public relation skills.	Has vital need for public relations skills.

This is by no means a complete matrix. This matrix is meant to be a sample. Your students may develop a matrix quite different from this based on previous experience and knowledge as well as your input.

Transparency Master #2

Demonstrated on this transparency is the concept that there are four common paths to management. The paths to management are represented by lines from each box directly to the management box. The length of each line represents the amount of time generally required to reach the goal of management. Alternate routes are also represented, such as going from one level of education to the next, or going directly into an entrepreneurial or partnership position. The left side of the chart is left blank so that you may add brief comments on advantages and disadvantages to various paths.

STUDENT ACTIVITIES

STUDENT WORKSHEET #1 — Evaluating my Career Goals

For additional activities, teachers may refer to the "Suggested Teaching Activities and Procedures" section in the Instructor's Guide.

STUDENT WORKSHEET #1

Evaluating my Career Goals

Part I

Name of Occupation ______________________________

Duties of the Worker

Job	Often	Frequent	Rarely

Personal Requirements

Age range ____________

Interests and abilities needed:

____

____

____

Personality and physical requirements:

____

____

____

Educational Requirements

Recommended high school program:

____

Post-high school education required or recommended (trade school, college, apprenticeship, on-the-job training):

____

Advantages and Disadvantages

(Earnings, hours, conditions, security of employment, opportunity for advancement)

Advantages: ____

____

____

Disadvantages ____

____

____

Present Demand & Future Outlook

Number of workers:

National ____________ State ____________ Local ____________

Present need for workers:

Great ______ Moderate ______ Slight ______

Probable future trend:

Little change ______ Increasing need ______ Decreasing need ______

Are jobs confined to certain areas?

Yes ______ No ______

Entering the Occupational Area

Any special entrance requirements (minimum education, entrance exams, experience, capital, licensing, union)

____

____

Source of additional information

____

Part II

Now that you have information on an occupation in which you are interested, it is time to identify and develop a short-term career plan. In the space below identify essential school courses or special training which you need to obtain before you are qualified for employment. Also identify essential skills or competencies needed in the occupation. Identify the date the training or competency was completed on the line beside it.

Occupation: *Conservation Technician* (Example)

Formal Courses/Special Training		Essential Competencies	
Example: *Ag Surveying*	*Fall 83*	*Keep records/record data*	*Fall 83*

Briefly explain how the FFA and your SAEP can be used to accomplish essential job competencies.

Example: A. I will participate in FFA Land-use Judging Contest.
B. I will develop the plans for and assist in installing drainage tile on 20 acres of our family farm this fall.

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Using Microcomputers in Agribusiness Management

RELATED PROBLEM AREAS:

1. Applying Mathematics Skills in Agriculture (Central Core Cluster)
2. Keeping and Using Records in Agricultural Occupations (Central Core Cluster)
3. Operating the Agribusiness
4. Operating the Horticultural Business (Horticulture Cluster)

PREREQUISITE PROBLEM AREA(S):

1. Keeping and Using Records in Agricultural Occupations (Central Core Cluster)

LEVEL: Preparatory

OCCUPATIONAL TASKS ADDRESSED:

Agricultural Business and Management Cluster

Duty H: Managing the Business

1. Utilize computerized inventory control systems
2. Establish computerized inventory control system
3. Use computer software for records and reports
4. Use computerized inventory system

Duty F: Financing the Agribusiness

1. Prepare cash flow statement
2. Prepare financial statements
3. Prepare budget
4. Record accounts payable in computerized bookkeeping system
5. Record accounts receivable in computerized bookkeeping system

Horticulture Cluster

Duty Q: Managing the Business

1. Use computerized network on agricultural marketing and management
2. Prepare periodic reports and financial statements using computer systems
3. Input accounting entries in a computerized bookkeeping system
4. Establish computerized inventory control system

STATE GOALS FOR LEARNING:

In planning the instruction for this problem area, teachers can promote the development of several student learning objectives which are related to the State Goals for Learning in Mathematics and Social Sciences. These objectives are listed on the Learning Assessment Plan forms included on the following page(s). Those learning objectives marked with an asterisk (*) are taken from the sample lists provided by the Illinois State Board of Education.

Illinois Agricultural Core Curriculum

Agricultural Education 124 Mumford Hall 1301 W. Gregory Drive University of Illinois Urbana, IL 61801

Director: Dale A. Law, Ed.D.
Principal Investigator: Jerry D. Pepple, Ed.D.
Research Assistant: Douglas L. Stockley

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100 North First Street
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LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date ____________
☐ Original submission ☐ Revision
Page _____ of _____

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☐ Mathematics ☒ Social Sciences
☐ Sciences ☐ Physical Development/Health

(Affix label or complete district information.)
COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐
District Name
City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to apply the skills and knowledge gained in the social sciences to decision making in life situations.

Contact Person: ____________
Title: ____________
Phone: ( )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Evaluate the costs and benefits of a particular course of action.					
*2. Understand the principles of money management including budgeting.					
*3. Apply the principles of money management to financial planning situations.					

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LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date ____________
☐ Original submission ☐ Revision
Page ____ of ____

(Affix label or complete district information.)

COUNTY ☐☐-☐ DISTRICT ☐☐☐☐ ESC ☐☐
District Name
City

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☒ Mathematics ☐ Social Sciences
☐ Sciences ☐ Physical Development/Health

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to understand and use methods of data collection and analysis, including tables, charts, and comparisons.

Contact Person: ____________
Title: ____________
Phone: ( )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Understand information management.					

ISBE 41-76 (1/88)

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LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date ____________
☐ Original submission ☐ Revision
Page ____ of ____

I. LEARNING AREA *(check one)*
☐ Language Arts
☒ Mathematics
☐ Sciences
☐ Fine Arts
☐ Social Sciences
☐ Physical Development/Health

(Affix label or complete district information.)
COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐
District Name
City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to identify, analyze, and solve problems using algebraic equations, inequalities, functions, and their graphs.

Contact Person: ____________
Title: ____________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Analyze graphs.					

ISBE 41-78 (1/88)

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Department of School Improvement Services
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Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

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Submission Date ______________
☐ Original submission ☐ Revision
Page ____ of ____

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☒ Mathematics ☐ Social Sciences
☐ Sciences ☐ Physical Development/Health

(Affix label or complete district information.)
COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐
District Name
City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to perform the computations of addition, subtraction, multiplication, and division using whole numbers, integers, fractions, and decimals.

Contact Person: ______________
Title: ______________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Use computational and problem-solving skills in real-life situations with or without a calculator as appropriate.					
*2. Understand financial packages.					
*3. Understand government and other types of financial documents.					
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INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Using Microcomputers in Agribusiness Management

STUDENT LEARNING OBJECTIVES

Upon completion of their study of this problem area, students will be able to:

1. Identify specific applications of microcomputers in agribusiness management.
2. Identify the components of a microcomputer system.
3. Identify software for microcomputers.
4. Identify reasons why microcomputers are useful in agribusiness management.
5. Identify sources of microcomputer software for agribusiness management.
6. Develop a cash flow statement using a spreadsheet program.
7. Develop a balance sheet using a spreadsheet program.
8. Develop a profit and loss statement using a spreadsheet program.
9. Develop an inventory recordkeeping system using a data base manager and/or a spreadsheet.
10. Use a recordkeeping program on a microcomputer for storing pertinent data and generating reports used for agribusiness management.
11. Use a modem to access information from a database.
12. Use a microcomputer system to generate agribusiness management reports that include graphics.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Using Microcomputers in Agribusiness Management

PROBLEMS AND QUESTIONS FOR STUDY	INSTRUCTOR'S NOTES AND REFERENCES

1. What uses do microcomputers have in agribusiness management?

2. How can the following programs be used for agribusiness management?
   a. spreadsheet
   b. database
   c. record keeping
   d. accounting
   e. graphics
   f. communications

3. How do you evaluate computer software?

4. Where can you find information about computer software?

5. What advantages and disadvantages exist when computerizing agribusiness management activities?

6. What computer hardware is required to perform various management functions?

7. How do you select computer hardware for agribusiness management applications?

8. What types of knowledge and skills are necessary to operate a microcomputer for agribusiness management?

9. When should an agribusiness begin using a microcomputer and what factors will influence this decision?

10. What agribusiness management activities can be computerized?

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Using Microcomputers in Agribusiness Management

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES

1. Have students visit an agribusiness that utilizes a microcomputer for management activities. Ask that the computer system be demonstrated to the class. As a result of the visit students should list the management activities that are being performed by the microcomputer along with the necessary hardware and software.

2. Have students list and compare the advantages and disadvantages of using a microcomputer to manage the agribusiness versus not using a microcomputer.

3. Given a case study of an agribusiness and its management activities, have students gather information in regard to how these activities can be met through the use of a microcomputer system. Students should be able to develop a report that would include:
    a. Management functions to be assisted by the microcomputer.
    b. Software required.
    c. Hardware required.
    d. Vendors of software and hardware.
    e. Costs.
    f. Justification of using a microcomputer.
    g. Estimated annual cost of maintaining a microcomputer system.
    h. Estimated useful life of the computer system.

4. Given an example of a cash flow statement and a microcomputer with a spreadsheet program, develop a cash flow statement that will perform automatic calculations. Then, given a set of data, input the data and develop a printed cash flow statement. (Repeat using profit and loss, balance sheet, and inventory.)

5. Given an example of an inventory record and a microcomputer with a database program, develop an inventory system. Then, given a list of inventory items and related information, enter the data and develop an inventory report. Related activities include developing specialized reports, sorting the database, searching and selecting specific information, and automatic mathematical computations.

6. Given reports generated from activities suggested in items #4 and #5 and a microcomputer with a graphics program, students should develop charts (line, bar, pie) that are appropriate and graphically explain the information found in the other reports.

7. Given a comprehensive record keeping or accounting software package and a microcomputer, have students enter data, generate reports, and perform other management activities that the system is capable of performing.

8. Invite a representative of a record keeping or accounting software company to demonstrate their product for the students. Have students evaluate the program for use in agri-business management. If a live demonstration is not possible, some companies have demo programs that simulate actual use of the program.

9. Compare and contrast similarities and differences between local agribusinesses and their use of microcomputers for management. (Example: Are the same activities computerized? Is similar software used? Do the same types of agribusinesses use the computer in similar ways?)

10. Given a budget and a list of management activities that need to be computerized, have each student choose the hardware and software they would purchase. This could be a research project concluding with written and/or oral reports.

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agribusiness Operation and Management

PROBLEM AREA: Using Microcomputers in Agribusiness Management

REFERENCES

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*Indicates highly recommended references

INSTRUCTOR'S NOTES AND REFERENCES

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INSTRUCTIONAL RESOURCES

These resources are intended for use by teachers in planning and teaching the materials for this problem area and may be adapted to fit the teaching method(s) used.

INFORMATION SHEET #1 — Management Information System (MIS)

INFORMATION SHEET #2 — Example Balance Sheet for Use on the Microcomputer

INFORMATION SHEET #3 — Example Profit and Loss Statement for Use on the Microcomputer

INFORMATION SHEET #4 — Example Inventory Record for Use on the Microcomputer

INFORMATION SHEET #5 — Example Cash Flow Statement for Use on the Microcomputer

INFORMATION SHEET #6 — Example Pie Charts Generated by a Spreadsheet Program

INFORMATION SHEET #7 — Example Bar Graphs Generated by a Spreadsheet Program

INFORMATION SHEET #8 — Terms to be Defined

INFORMATION SHEET #1

Management Information System (MIS)

Many MIS operations perform quite well using hand generated reports. However, as businesses grow larger, this approach begins to fail because of the volume of data.

It is often valuable to the firm to develop a system to ensure that managers get all the information they need to operate effectively. Many managers are utilizing microcomputers to assist in handling the essential data.

The first step in the development of a management information system is to determine the types of information that management needs in order to measure business performance properly.

To be useful, information must be accurate, timely, in a useable form, and cost less than the benefit it generates. If a computer is able to help you manage information more efficiently while being cost effective, then it should be considered for use as part of the MIS.

INFORMATION SHEET #2

Example Balance Sheet for Use on the Microcomputer

Assets		
Current assets:		
Cash	$ 25,000	
Accounts receivable	$ 50,000	
Inventory	$ 80,000	
Prepaid expenses	$ 20,000	
Other	$ 10,000	
Total current assets		$185,000
Fixed assets:		
Land	$ 15,000	
Buildings	$ 50,000	
Less: Accumulated depreciation	($ 20,000)	
	$ 45,000	
Equipment	$150,000	
Less: Accumulated depreciation	($ 75,000)	
	$ 75,000	
Total fixed assets		$120,000
Other assets		$ 25,000
Total assets		$330,000
Liabilities		
Current liabilities:		
Accounts payable	$ 83,000	
Notes payable	$ 75,000	
Taxes payable	$ 3,000	
Wages payable	$ 1,500	
Total current liabilities		$162,500
Long-term liabilities:		
Mortgages	$ 78,500	
Other	$ 15,000	
Total long-term liabilities		$ 93,500
Total liabilities		$256,000
Net Worth		
Owner-invested capital:		
Common stock	$ 50,000	
Retained earnings	$ 24,000	
Total net worth		$ 74,000
Total liabilities and net worth		$330,000

Note: Many spreadsheet programs enclose negative numbers in parentheses.

INFORMATION SHEET #3

Example Profit and Loss Statement for Use on the Microcomputer

Sales		$500,000
Cost of goods sold		($250,000)
Gross margin		$250,000
Operating expenses		
Salary and wages, including benefits	($85,000)	
Local taxes, licenses	($ 5,000)	
Insurance	($ 6,000)	
Depreciation	($20,000)	
Rent and lease	($ 7,000)	
Advertising and promotion	($ 5,000)	
Office expense	($ 2,000)	
Utilities	($ 3,000)	
Maintenance and repair	($17,000)	
Bad-debt loss	($ 2,000)	
Supplies	($ 4,000)	
Other	($ 4,000)	
Total operating expense		($160,000)
Net operating profit	$90,000	
Interest expense	($15,000)	
Other non-operating income	$ 5,000	
Net profit before taxes		$ 80,000
Profit taxes		($ 40,000)
Net profit after taxes		$ 40,000

Note: Many spreadsheet programs enclose negative numbers in parentheses.

INFORMATION SHEET #4

Example Inventory for Use on the Microcomputer

Quantity	Units	Item Description	Purchase Date	Purchase $/Unit	Purchase Total $	Current $/Unit	Current Total $	Current Location	Identification Number
500	Tons	0-0-62	00/00/00	$160.00	$80,000.00	$170.00	$85,000.00	Bin 6	
400	Tons	18-46-0	00/00/00	$240.00	$96,000.00	$255.00	$102,000.00	Bin 8	
300	Tons	0-46-0	00/00/00	$230.00	$69,000.00	$240.00	$72,000.00	Bin 7	
100	Tons	46-0-0	00/00/00	$200.00	$20,000.00	$230.00	$23,000.00	Bin 10	
500	Tons	82-0-0	00/00/00	$170.00	$85,000.00	$190.00	$95,000.00	Tank 2	
400	Gals	Chem X	00/00/00	$60.00	$24,000.00	$27.00	$10,800.00	Bldg 3	02589208
800	Gals	Chem Y	00/00/00	$70.00	$56,000.00	$85.00	$68,000.00	Bldg 3	025729078
1000	Gals	Chem Z	00/00/00	$80.00	$80,000.00	$95.00	$95,000.00	Bldg 2	3490850938
200	Gals	Chem A	00/00/00	$40.00	$8,000.00	$50.00	$10,000.00	Bldg 2	0392458098
800	Gals	Chem B	00/00/00	$55.00	$44,000.00	$65.00	$52,000.00	Bldg 2	054023840
750	Gals	Chem C	00/00/00	$65.00	$48,750.00	$75.00	$56,250.00	Bldg 3	2984502380
750	Gals	Gasoline	00/00/00	$1.05	$787.50	$1.05	$787.50	Plant	
1500	Lbs	Insecticide	00/00/00	$3.00	$4,500.00	$3.50	$5,250.00	Bldg 2	
1		4WD Pickup	00/00/00		$15,000.00		$9,000.00	Bldg 1	0Q2048028500985408
1		4WD Pickup	00/00/00		$18,000.00		$14,000.00	Bldg 1	2039852384502835
1		Pickup Sprayer	00/00/00		$14,000.00		$7,000.00	Bldg 1	JF2763724784U68
1		Spray Cart	00/00/00		$12,500.00		$10,000.00	Bldg 1	HJ667356873472
1		Big Wheels	00/00/00		$80,000.00		$45,000.00	Bldg 1	I91874590127459127
20		Fert Buggies	00/00/00	$1,500.00	$30,000.00	$750.00	$15,000.00	Plant	
1		Anhydrous Bulk Tank	00/00/00		$25,000.00		$20,000.00	Plant	
20		Anhydrous Toolbars	00/00/00	$1,100.00	$22,000.00	$600.00	$12,000.00	Plant	
40		Anhydrous Tanks	00/00/00	$900.00	$36,000.00	$500.00	$20,000.00	Plant	
1		Fertilizer Blender	00/00/00		$4,500.00		$2,500.00	Plant	TY476474586847
1		Payloader	00/00/00		$16,000.00		$16,000.00	Bldg 1	WRTY365783568
1		Utility Tractor	00/00/00		$9,000.00		$3,000.00	Bldg 1	9Q0587-2349857098
1		Portable Welder	00/00/00		$6,000.00		$4,000.00	Shop	SF27624572678GH45
1		Air Compressor	00/00/00		$2,500.00		$2,000.00	Shop	4256234767676245
1		Computer System	00/00/00		$5,000.00		$5,000.00	Office	23453245256
3		Office Desks	00/00/00	$500.00	$1,500.00	$500.00	$1,500.00	Office	
1		Communication System	00/00/00		$15,000.00		$10,000.00	Office	23456234256
		Totals			$928,037.50		$871,087.50		

INFORMATION SHEET #5

Example Cash Flow Statement for Use on the Microcomputer

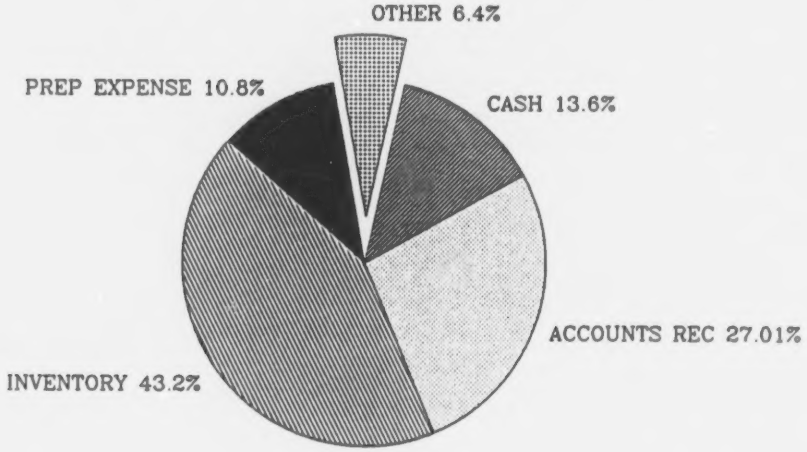
	1 January	2 February	3 March	4 April	5 May	6 June	7 July	8 August	9 September	10 October	11 November	12 December
Balance Brought Forward	2000	1973	50302	25024	89859	69583	69419	62669	60119	60629	57839	51382
Cash receipts:												
1. Cash sales	4589	36891	39586	78026	8789	9365	10896	8789	8789	8789	8789	8789
2. Accounts receivable	6895	25613	25698	4646	4646	4646	4646	4646	5896	4646	4646	4646
3. Other income	25	54	54	54	54	54	54	54	54	54	54	54
4. Total cash receipts	11509	62558	65338	82726	13489	14065	15596	13489	14739	13489	13489	13489
Cash payments:												
5. Raw materials	(5685)	(6464)	(56987)	(6464)	(26000)	(6464)	(6464)	(6464)	(6464)	(6464)	(6464)	(6464)
6. Payroll	(5689)	(5689)	(5689)	(5689)	(5689)	(5689)	(5689)	(5689)	(5689)	(5689)	(5689)	(5689)
7. Loans & other expenses	(52)	(548)	(548)	(548)	(548)	(548)	(1589)	(2358)	(548)	(2598)	(548)	(548)
8. Advertising	(25)	(458)	(458)	(458)	(458)	(458)	(2589)	(458)	(458)	(458)	(5986)	(5987)
9. Selling expense	(25)	(69)	(69)	(2598)	(69)	(69)	(2569)	(69)	(69)	(69)	(258)	(69)
10. Administrative expense	(35)	(878)	(878)	(878)	(878)	(878)	(878)	(878)	(878)	(878)	(878)	(878)
11. New plant and equipment	(25)	(123)	(25987)	(1256)	(123)	(123)	(2568)	(123)	(123)	(123)	(123)	(123)
12. Other payments	0	0	0	0	0	0	0	0	0	0	0	0
13. Total cash payments	(11536)	(14229)	(90616)	(17891)	(33765)	(14229)	(22346)	(16039)	(14229)	(16279)	(19946)	(19758)
New short-term loans:												
14. Monthly payment	0	0	0	0	0	0	0	0	0	0	0	0
New long-term loans:												
15. Monthly payment	0	0	0	0	0	0	0	0	0	0	0	0
16. Cash balance	1973	50302	25024	89859	69583	69419	62669	60119	60629	57839	51382	45113

Note: Many spreadsheet programs enclose negative numbers in parentheses.

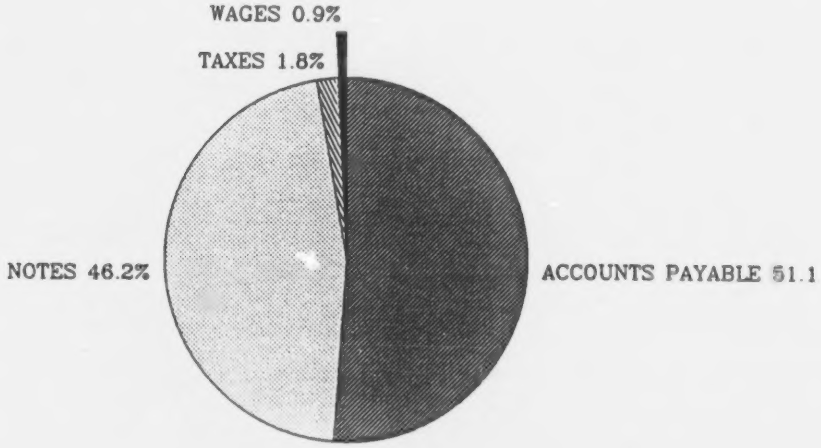
INFORMATION SHEET #6

Example Pie Charts Generated by a Spreadsheet Program

(Refer to Information Sheet #2 for Corresponding Figures)



CURRENT ASSETS

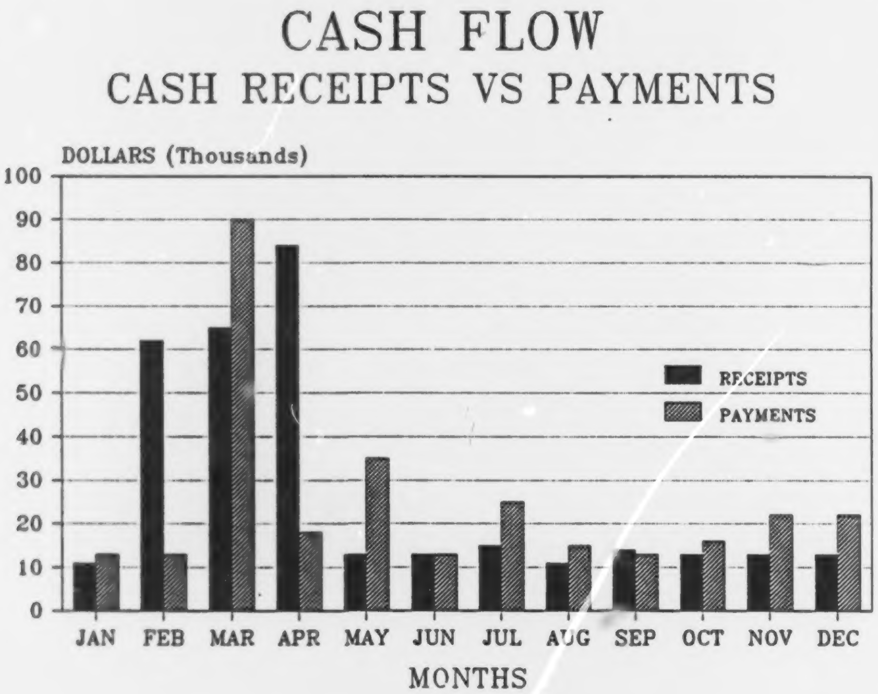


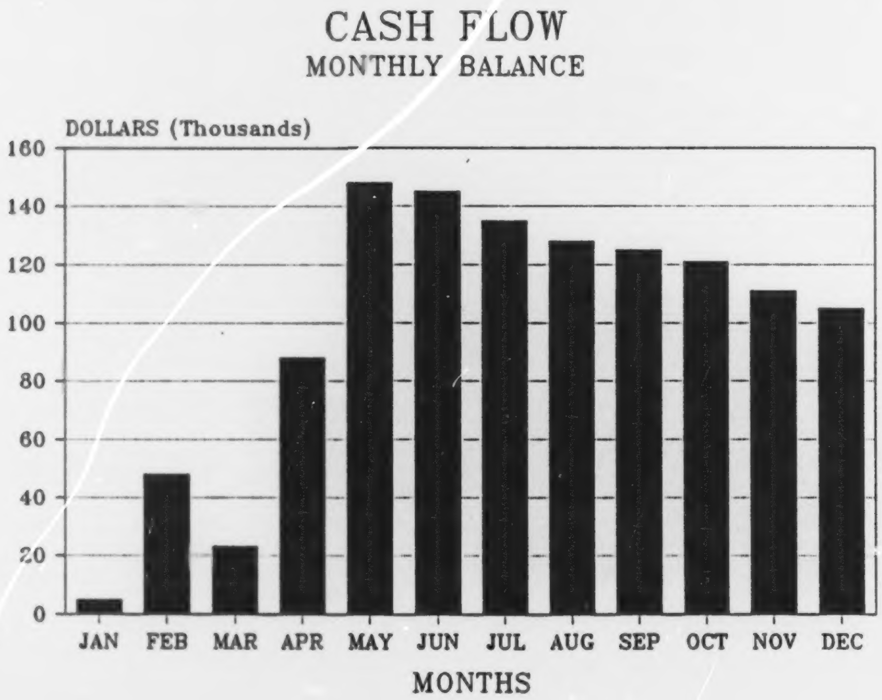
CURRENT LIABILITIES

INFORMATION SHEET #7

Example Bar Graphs Generated by a Spreadsheet Program

(Refer to Information Sheet #5 for Corresponding Figures)





INFORMATION SHEET #8

Terms to be Defined

BASIC — a type of computer language; stands for Beginner's All-Purpose Symbolic Instruction Code.

Baud — the rate at which computers can send and receive information to and from other computers. One character per second equals a baud rate of about 10. Today the minimum baud rate on most modems is 1200 and the standard is 2400 baud or 240 characters per second.

bps — an abbreviation for Bits Per Second or sometimes Bytes Per Second.

Bit — a single signal; smallest unit of information recognized by the computer.

Buffer — an area of storage used to temporarily hold data being transferred from one device to another. Used to compensate for the different rates at which hardware devices process data: for example, a buffer would be used to hold data waiting to print, in order to free the CPU for other tasks, since it processes data at a much faster rate.

Byte — a group of eight bits; one character equals one byte.

Cathode ray tube (CRT) — an electronic tube with a screen upon which information may be displayed.

CD-ROM — stands for Compact Disk Read-Only Memory, which refers to the use of compact disks similar to audio compact disks as a computer storage medium. A computer CD uses the same principle to store information. Computer CDs have capacities of several hundred megabytes (10 to 50 times as much information as can be stored on a typical 5 1/4 inch floppy disk). Computer CDs are "read-only" becuase the user cannot store information on the disk; they can only be used to retrieve the information that has been stored on them by the supplier.

Central processing unit (CPU) — major component of a computer system; housed inside the unit that holds the keyboard; processes all data.

CGA — the IBM Color/Graphics Adapter (CGA) was for a long time the most popular video card for the IBM PC. The CGA was designed for video games, not office applications. The lettering on the screen is too blurry for extended sessions of word processing or programming.

Compact disk (CD) — a metallic disk similar to the audio disks used to store music. These disks are capable of storing 500+ megabytes of text, numbers, and graphic images — all combined, perhaps, with audio and visual materials. Some CDs are prerecorded while others are erasable and able to have information re-written on them.

Compact disk (CD) player — a device capable of reading (playing) CDs that have been prerecorded in the factory.

Coprocessor — an auxiliary processor that assumes certain functions in order to free the central processing unit; the speed of the operation is thus increased.

cps — an abbreviation for Characters Per Second, a unit for measuring the output speed of printers.

Database — a collection of data files containing complete information on a particular subject, organized for rapid search and retrieval.

Dedicated system — a computer system designed primarily for one purpose, such as word processing or graphics.

Digitizer — a unit that converts analog representations (such as a drawing or music) into digital form.

EGA — the IBM Enhanced Graphics Adapter (EGA) provides all the graphics modes of the Color/Graphics Adapter (CGA), as well as additional high-resolution modes and sharper text.

Floppy disk — thin, flexible, magnetic disk used to record and retrieve data. The disk is contained within a protective cover. Size is usually 3 1/2" or 5 1/4".

Gigabyte — specifically, 1,073,741,824, or 2^{30} bytes; more loosely, one billion bytes, one million kilobytes, or one thousand megabytes; abbreviated GB.

Hard disk — a data storage device which may be located in the computer or attached as a separate unit. With a hard disk system, you cannot remove the disk from this drive. A hard disk drive consists of a motor turning an aluminum platter coated with iron oxide to provide a magnetic medium. It also has read/write heads for accessing information on the platters. The chief advantages of a hard disk are the ability to store lots of information and to save and retrieve that information very quickly. Many programs work better (faster) with a hard drive or fixed disk. Capacity of hard disk units for microcomputers varies from 10 million characterers to over a billion characters or more.

Hardware — the physical equipment in a computer system; examples include disk drives, keyboard, monitor, and printer.

Impact printer — most popular type of dot matrix printer; ranges in price from $200 to $2,000; uses regular paper and has excellent quality of type.

Integrated software — a program or series of programs with multiple functions designed to work in harmony (word processing, spreadsheet, and database management is a common combination). Integrated software allows free transfer of information from one program to another.

Interface — an electronic component that allows one program, device, or system to communicate with another.

Kilobyte (K) — specifically, 1024 bytes. It is commonly abbreviated K and used as a suffix when describing memory size.

Laser printer — a printing device in which tiny beams of electromagnetic energy in the light spectrum (laser beams) are used to form images of the information to be printed.

Mainframe computers — very large and expensive computers; introduced in the 1950s; housed in specially designed rooms; cost over $100,000.

Megabyte (M) — specifically, 1,048,576, or 2^{20} bytes; more loosely, one million bytes or one thousand kilobytes; abbreviated MB.

MHz — an abbreviation for megahertz, one million cycles per second.

Microcomputers — small-size computers; operates using an electric, silicon chip; units can be mass produced; relatively low cost.

Minicomputers — smaller units than mainframe computers; introduced in the mid-1960s; range in price from $10,000 to $25,000.

Modem (modulator/demodulator) — a device that converts digital signals from a computer into auditory tone variations and transmits them over standard telephone lines.

Mouse — a small, hand-held control device that you move on a desktop to make the cursor move across the computer screen. A mouse offers fingertip rather than keyboard control of the computer.

Networking — a technique for distributing data processing functions through communications facilities; the interconnection of two or more networks. A network is a set of computers connected together. A Local Area Network (LAN) has its computer equipment confined to a small area (room, building, site) and is interconnected by dedicated communications channels. These computers not only can intercommunicate but also can share resources such as disk storage and printers.

Peripheral devices — any device connected to the computer; examples include printers, video screens, and memory storage.

Random access memory (RAM) — storage units into which data can be written or read.

Read only memory (ROM) — storage areas that are permanently wired to perform one function or contain specific data.

Scanner — a device that enables a computer to read a printed or handwritten page. The simplest scanners give the contents of the page to the computer as a graphic image — a handy way of putting pictures into the computer. More advanced scanners can read the letters of typewritten text, transmitting them into the computer as if they were typed on the keyboard. This process is seldom 100% accurate.

Software — programming designed for use with a computer; programs come with a manual explaining the specifics of the program.

Spreadsheet — software that generates a worksheet, often two-dimensional, similar to that used in a business or scientific undertaking. The user can indicate the relationship between data entries. When the data are changed, the program can readjust the relationships immediately.

Terabyte — Specifically, 1,009,511,627,776, or 2^{40} bytes; more loosely, one thousand gigabytes, one million megabytes, one billion kilobytes, or one trillion bytes; used to measure capacities of optical disk mass storage divices; abbreviated TB.

VGA — the IBM Video Gate Array (VGA) is the video circuit built into the PS / 2 computers. It provides high-resolution graphics modes and crisp text as well as emulation of the CGA and EGA.

Virus — a computer program that automatically copies itself, thereby "infecting" other disks or programs without the user knowing it, and then plays some kind of trick or disrupts the operation of the computer.

Worm — an acronym for Write Once, Read Many storage, which refers to a type of optical disk where a computer can save information once, can then read that information, but cannot change it.

STUDENT ACTIVITIES

STUDENT WORKSHEET #1 — Business Interview — Microcomputers

STUDENT WORKSHEET #2 — Computer Software

STUDENT WORKSHEET #3 — Hardware Evaluation Checklist

STUDENT WORKSHEET #4 — Software Evaluation Checklist

For additional activities, teachers may refer to the "Suggested Teaching Activities and Procedures" section in the Instructor's Guide.

STUDENT WORKSHEET #1

Business Interview — Microcomputers

1. Name and address of business: ______________________________

____

______________________________ ________ (   )   - ____________
zip phone

2. Nature of business: ______________________________

____

3. Number and type of computers:

Quantity	Manufacturer	Model
______	______________	________
______	______________	________

4. Peripheral devices (please list): ____________ ____________

____________ ____________ ____________

____________ ____________ ____________

5. Source of computer training: (Check all that apply)

_______ a. self

_______ b. high school

_______ c. college

_______ d. on-the-job

_______ e. military

_______ f. other (specify) ____________

6. Uses for microcomputer:

_______ a. employee records (example: payroll)

_______ b. inventory of crops, animals, equipment and/or supplies

_______ c. sales and marketing analysis

_______ d. management assistance (feed ration calculations, fertilizer recommendations, etc.)

_______ e. customer records (example: billing)

_______ f. financial planning and record keeping (example: budgeting)

_______ g. other (specify) ______________________________

_______ h. other (specify) ______________________________

7. Software used for management activities:

Name of Software Package	Vendor
______________	______________
______________	______________
______________	______________
______________	______________
______________	______________

8. Microcomputer skills needed by entry level workers: ______________________________

____

____

____

____

9. Estimated annual maintenance cost for the computer system(s): $ ____________________

10. Estimated useful life for the computer system(s): ____________________ Years

STUDENT WORKSHEET #2

Computer Software

(Use with VAS Unit #U6025, *Selecting Agricultural Computer Software*)

1. List the three main types of computer software and briefly define each.

   a. ____

   b. ____

   c. ____

2. Briefly explain why brand "Z" computer may be unable to utilize another company's software.

3. How might the problem described in question #2 be corrected while still utilizing opposing brands?

4. List the four most common programming languages.

   a. ____________________

   b. ____________________

   c. ____________________

   d. ____________________

5. Approximately how many versions or dialects of BASIC exist? ____________________

6. If you are planning to use your microcomputer primarily to **run** programs rather than for **developing** programs, would you purchase a microcomputer with a compiler or an interpreter? Explain your answer.

7. List and briefly describe the three types of application software packages.

a. ______________________________

b. ______________________________

c. ______________________________

8. List eight things you should check when evaluating commercial software packages.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

g. ______________________________

h. ______________________________

9. Describe the following *general* commercial programs available for use as agricultural software.

a. Database Management programs ______________________________

b. Word Processing programs ______________________________

c. Spreadsheet programs ______________________________

d. Graphic programs ______________________________

10. Identify the types of reports that commercial record keeping programs usually generate.

11. Compare the advantages and disadvantages in using commercial, custom, or user-written software.

Disadvantages	Advantages

12. Where might you obtain information about available software?

STUDENT WORKSHEET #3

Hardware Evaluation Checklist

Procedure:

Visit a local microcomputer dealer or use available dealer catalogs to complete the following hardware checklist. Fill in the blanks and circle the appropriate letter in the right-hand column.

Brand Name: ____

Model: ____

Price: ________________________

Keyboard/Disk Drive/Memory	Yes	No	Not Applicable
1. Sold by a local dealer who provides service	Y	N	NA
2. Manufacturer warranty (__________ mos.)	Y	N	NA
3. Service contract available	Y	N	NA
4. Name brand computer that has software available	Y	N	NA
5. Sufficient memory (__________ RAM)	Y	N	NA
6. Additional memory can be purchased	Y	N	NA
7. Uses a 5 1/4" _____ or 3 1/2" _____ diskette	Y	N	NA
8. Can be connected to a phone modem to access other computers	Y	N	NA
9. Additional disk drives can be added if necessary	Y	N	NA
10. Hard drive (at least 20 megabytes) (__________ meg)	Y	N	NA
11. Adequate graphics capabilities	Y	N	NA
12. Keyboard clearly marked and easy to operate (# of keys __________)	Y	N	NA
13. Adequate capacity to support other peripheral devices	Y	N	NA
14. Will operate a color monitor	Y	N	NA
15. Price comparable to similar brands	Y	N	NA
16. Operating speed is adequate (__________ mhz)	Y	N	NA
Monitor/Printer			
1. Picture is sharp and clear	Y	N	NA
2. Monitor has high-resolution color screen	Y	N	NA
3. Printer has desired speed of print (__________ cps draft)	Y	N	NA
4. Printer provides graphics capabilities	Y	N	NA
5. Printer provides letter quality type (should provide a selection of font types and sizes)	Y	N	NA

Questions:

Answer the following questions after completing the procedures portion of the checklist.

1. What do you want to do with the computer? List your goals.

2. Is there a less expensive way to do what you want? Explain.

3. How will repairs and questions about equipment be handled? Explain.

4. Do you have adequate space and power sources to operate the microcomputer? Explain.

5. Would you purchase the hardware just evaluated? Why or why not?

STUDENT WORKSHEET #4

Software Evaluation Checklist

Procedure:

Visit a local microcomputer dealer or use a program available at school to complete the following software checklist. Circle the appropriate letter in the right-hand column.

Name of Program: ______________________________

Price: $ ______________________

Nature of Program: ______________________________

This program will run on the following computers: ______________________________

____

____

What size RAM capacity is required to operate this program?
minimum ________
optimum ________

What computer hardware is recommended to operate this program?
minimum ________ ________ ________ ________ ________
optimum ________ ________ ________ ________ ________

General	Yes	No	Not Applicable
1. Provides desired output	Y	N	NA
2. Dealer or company provides service	Y	N	NA
3. Will operate on desired hardware	Y	N	NA
4. Does not require more memory (K) than the hardware has available	Y	N	NA
5. Price comparable to similar programs	Y	N	NA
6. Program free from errors	Y	N	NA
7. Can be modified to meet your needs	Y	N	NA
8. Clear graphics can be used when needed	Y	N	NA
9. Sound and/or music used effectively	Y	N	NA
Input			
1. Cursor or other indicator shows where input is to go	Y	N	NA
2. Can be corrected if necessary before program continues	Y	N	NA
3. Error diagnostics given when improper data is inputted	Y	N	NA
Output			
1. Easy to read and understand format	Y	N	NA

	Yes	No	Not Applicable
2. Produces output on a printer if desired	Y	N	NA
3. In color for color monitors	Y	N	NA
Instructions — on screen			
1. Documentation provided throughout the software package	Y	N	NA
2. User can skip instructions and return to them when needed	Y	N	NA
3. Text is clear and easy to read	Y	N	NA
4. Commands written in simple-to-understand terms	Y	N	NA
5. Uniform terms used throughout the program	Y	N	NA
6. Contains a tutorial	Y	N	NA
Documentation — off screen			
1. Provides easy-to-read, step-by-step instructions	Y	N	NA
2. Contains a sample set of data with examples of reports that can be generated	Y	N	NA
3. Contains a tutorial	Y	N	NA
4. Provides a summary list of program's commands	Y	N	NA

Questions:

Answer the following questions after running a sample software package.

1. Were there times when you felt explanations were unclear? Explain.

2. Were there times when you felt frustrated using the program? Explain.

3. Were there times when you lost interest in the program? Explain.

4. What features of the program did you most like or enjoy?

5. What features of the program did you least like or enjoy?

6. How could this program be useful to you?

UNIT B: Animal Science

PROBLEM AREAS:

1. Understanding the Animal Production Industry
2. Classifying Animals
3. Understanding Animal Anatomy and Physiology
4. Meeting Nutritional Needs of Animals
5. Understanding Animal Breeding and Reproduction
6. Maintaining Animal Health
7. Meeting the Environmental Requirements of Animals
8. Identifying Alternative Animal Production Systems: Aquaculture
9. Conserving Wildlife Resources
10. Caring for Animals
11. Identifying Career Opportunities in Animal Science
12. Understanding Economic Principles of Livestock Production

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Understanding the Animal Production Industry

RELATED PROBLEM AREAS:

1. Understanding the World Food and Fiber Chain (Central Core Cluster)
2. Recognizing the Role of Agriculture in the Society (Central Core Cluster)
3. Recognizing the Impact of Technology on Agriculture: Biotechnology (Central Core Cluster)
4. Classifying Animals
5. Understanding Animal Anatomy and Physiology
6. Meeting Nutritional Needs of Animals
7. Understanding Animal Breeding and Reproduction
8. Maintaining Animal Health
9. Meeting the Environmental Requirements of Animals

PREREQUISITE PROBLEM AREA(S): None

LEVEL: Orientation

OCCUPATIONAL TASKS ADDRESSED: None

STATE GOALS FOR LEARNING

In planning the instruction for this problem area, teachers can promote the development of several student learning objectives which are related to the State Goals for Learning in Biological and Physical Sciences and Social Sciences. These objectives are listed on the Learning Assessment Plan forms included on the following page(s). Those learning objectives marked with an asterisk (*) are taken from the sample lists provided by the Illinois State Board of Education.

Illinois Agricultural Core Curriculum

Agricultural Education 124 Mumford Hall 1301 W. Gregory Drive University of Illinois Urbana, IL 61801

Director: Dale A. Law, Ed.D.
Principal Investigator: Jerry D. Pepple, Ed.D.
Research Assistant: Robert E. Petrea

Submission Date________________
☐ Original submission ☐ Revision
Page _____ of _____

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☐ Mathematics ☒ Social Sciences
☐ Sciences ☐ Physical Development/Health

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)

COUNTY	DISTRICT	ESC
☐☐☐	☐☐☐☐	☐☐

District Name

City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to apply the skills and knowledge gained in the social sciences to decision making in life situations.

Contact Person: ____________________
Title: ____________________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Understand that human activities can be classified by means of identifying the production and consumption of goods and services.					
*2. Analyze an individual's daily activities to determine his or her role as producer, consumer and citizen.					
*3. Recognize that competence in a field of work entails the development of a wide range of skills.					
*4. Compare the economic interdependence among agriculture, business, government, labor, and consumer.					
5. Explain the importance of the animal production industry to the economy of Illinois in general and to the Illinois farm community in particular.					
6. Analyze the consumer's role in determining the output of the animal production industry.					

ISBE 41-76 (1/88)

Submission Date ____________
☐ Original submission ☐ Revision
Page ____ of ____

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☒ Sciences ☐ Physical Development/Health

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)

COUNTY	DISTRICT	ESC

District Name
City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will have a working knowledge of the social and environmental implications and limitations of technological development.

Contact Person: ____________
Title: ____________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Understand the impact of technological developments on society.					
*2. Understand the interdependence of science, technology, and the economy relative to their development.					
3. Predict the impact of the technological advances on the animal production industry.					
4. Explain the importance of the animal production industry to the economy of Illinois in general and to the Illinois farm economy in particular.					

ISBE 41-78 (1/86)

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Understanding the Animal Production Industry

STUDENT LEARNING OBJECTIVES

Upon completion of their study of this problem area, students will be able to:

1. Define terms integral to the animal production industry.
2. Describe the basic trends in the animal production industry based on historical data.
3. Identify Illinois' position in the U.S. in producing various animal species.
4. Describe characteristics of specific animal enterprises and name the associations where specific information may be obtained.
5. Explain the importance of the animal production industry to the economy of Illinois in general and to the Illinois farm economy in particular.
6. Predict the impact of technological advances on the animal production industry.
7. Analyze the consumer's role in determining the output of the animal production industry.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Understanding the Animal Production Industry

PROBLEMS AND QUESTIONS FOR STUDY

1. What are the various livestock enterprises?
2. How many farms have livestock?
3. Which animals are the most popular?
4. Which states produce the most livestock?
5. How does Illinois rank in producing the various animals?
6. How important is livestock to Illinois economy?
7. How important is livestock to the farm economy?
8. Has Illinois always produced the same number of animals and products each year? If not, why is there a difference from year to year?
9. Which parts of the state produce the most livestock?
10. Which county produces the most beef? Swine? Sheep? Milk?
11. Why is there a difference in the number of animals produced in the regions of the state?
12. Where can one find more information about specific types and breeds of livestock?
13. Why is it important to understand the animal production industry?
14. Where can one find information about agriculture?

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Understanding the Animal Production Industry

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES

1. Use local enterprise operators and agencies, such as the Cooperative Extension Service, and livestock associations as resources for information.

2. Use local production owners, herdsmen, sale barn managers, slaughter facility managers, livestock association representatives, and Cooperative Extension personnel as guest lecturers for classroom presentations.

3. Conduct field trips to local production facilities, sale barns, slaughter and packing plants, grocery stores, clothing stores, and other facilities to observe the breadth of the animal production industry and occupations available within the industry.

4. Have students keep a survey for one week of all the animal products they either consume or use. Lead a discussion as to why these particular products were chosen.

5. Use the information sheets and transparency masters as resources for content delivery and the completion of student worksheets.

6. Assign individual students a specific county or region of the state, and have them investigate the number and value of animals produced in that county or region.

7. Use appropriate VAS materials as references and resources for completion of student worksheets.

8. Lead students in a discussion of alternative animal production enterprises such as mink and honey production. Have students identify specific examples from the local area.

9. Divide the class into small groups and have them research and answer questions such as:
   a. How is the animal industry important to me?
   b. Why should I be concerned with the way animals are produced by the animal production industry?
   c. What animal production enterprise am I most interested in?

10. Have students pick an animal association from those listed in Information Sheet #2 and write the association for information. Have students use the information in a report to the class on the animal production industry.

11. Lead students in a discussion of predictions on the future of the various animal enterprises based on resource materials.

12. Have students research livestock association periodicals, specific animal magazines, industry publications, and newspapers for current topics of concern to the animal production industry.

13. Obtain copies of *1988 Fact Book of Agriculture* for use by the class as a text of the current state of agriculture and its attendant components.

14. Use problem area, *Recognizing the Impact of Technology on Agriculture: Biotechnology*, as a resource for topics of discussion concerning biotechnology's role in the animal production industry.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Understanding the Animal Production Industry

REFERENCES

*1. *1988 Fact Book of Agriculture.* (Misc. Publication #1063). U.S. Department of Agriculture, Office of Governmental and Public Affairs, Washington, DC 20250.

*2. *Animal Summary - Illinois Agriculture Statistics 1988.* Agricultural Statistics Board Publications, Room 5829, South Building, U.S. Department of Agriculture, Washington, DC 20250. (Free of charge to Illinois residents).

*3. *The Swine Enterprise* (VAS Unit #U1029A); *The Sheep Enterpirse* (VAS Unit #U1031A); *The Beef Breeding Enterprise* (VAS Unit #U1056); *The Feeder Cattle Enterprise* (VAS Unit #U1057); *Animals in World Agriculture* (VAS Unit #U1058); *New and Exotic Breeds of Beef Cattle* (VAS Filmstrip #F104). Vocational Agriculture Service, College of Agriculture, University of Illinois, 1401 S. Maryland Drive, Urbana, IL 61801. (217) 333-3871.

4. Any of the science texts on specific animal species by M.E. Ensminger. Available from: Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

*Indicates highly recommended reference

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTIONAL RESOURCES

These resources are intended for use by teachers in planning and teaching the materials for this problem area and may be adapted to fit the teaching method(s) used.

INFORMATION SHEET #1 — Introduction to Illinois Animal Production Industry

INFORMATION SHEET #2 — Breed Registry Association

TRANSPARENCY MASTER #1 — Leading States in Livestock Industries

TRANSPARENCY MASTER #2 — Leading States in Livestock Industries

TRANSPARENCY MASTER #3 — Illinois Rank in Agriculture

TRANSPARENCY MASTER #4 — Illinois Rank in Agriculture

TRANSPARENCY MASTER #5 — Illinois Rank in Agriculture

TRANSPARENCY MASTER #6 — The Livestock Industry in Illinois

TRANSPARENCY MASTER #7 — Illinois Cash Farm Income by Commodities 1986

TRANSPARENCY MASTER #8 — Trends in Illinois Livestock Production

TRANSPARENCY MASTER #9 — Counties Leading in Livestock Inventory — January 1, 1988

TRANSPARENCY MASTER #10 — Livestock Cash Receipts — 1986

TRANSPARENCY MASTER #11 — All Cattle Inventory — January 1, 1988

TRANSPARENCY MASTER #12 — All Hog Inventory — December 1, 1987

TRANSPARENCY MASTER #13 — Dairy Cattle in Illinois

TRANSPARENCY MASTER #14 — Cattle and Calf Slaughter — 1977-1988

TRANSPARENCY MASTER #15 — Hog, Sheep, and Lambs Slaughter

INFORMATION SHEET #1

Introduction to Illinois Animal Production Industry

Farms with Animals

Although many farms in the State have become specialized for the production of crops such as corn and soybeans, there are still 38,000 farms that have cattle; 15,500 farms have hogs; 5,100 have sheep; and 5,000 have dairy cattle. Cattle are found throughout the State, but populations are most concentrated in the Northwest. Dairy production is concentrated in the North and Southwest. Hogs and pigs are on farms throughout the State, but the largest populations are in the Western and Northwestern areas of the state. Livestock production contributes nearly a third of the total cash receipts from Illinois farms.

Livestock, Dairy, and Poultry

Illinois cattle, hog, and sheep producers received $1.75 billion from marketings in 1986, 5% above the $1.67 billion received in 1985. Cash receipts for cattle at $739.8 million and hogs at $1.01 billion, were up 11% and 2% respectively, while receipts for sheep were down 26% at $5.46 million. This compares with 1985 receipts of $671.0 million for cattle, $992.8 million for hogs, and $7.4 million for sheep.

Cash receipts for Illinois egg producers were $32.8 million in 1986, a 1% decline from the $33.2 million received in 1985.

Milk receipts in 1986 totaled $344.6 million or 1% more than the $340.1 million received in 1985

All livestock and livestock products in Illinois generated total cash receipts of $2.14 billion in 1986, up 4% from the 2.05 billion cash receipts in 1985 and almost equivalent to 1984 receipts of $2.17 billion.

Illinois and United States Total Exports, by Selected Commodities

Commodities		Fiscal Year Ending September 30						
		1981	1982	1983	1984	1985	1986	1987
		Million Dollars						
Feed Grains & Products		1675.1	1284.4	1301.2	1316.0	1197.6	813.1	738.4
Soybeans & Products		1391.0	1481.5	1257.9	1231.9	804.2	1016.8	1048.0
Wheat & Products		298.0	309.3	179.7	156.5	113.8	63.7	52.5
Live Animals & Meat (Ex. Poultry)		57.0	45.3	40.3	42.0	38.5	47.3	57.4
Hides and Skins		30.0	25.7	21.9	36.8	37.6	47.5	56.2
Fats, Oils, & Greases		30.5	21.9	15.4	21.9	19.4	17.3	15.8
Total	ILLINOIS	3614.2	3312.8	2950.2	2930.1	2333.7	2142.5	2115.3
	UNITED STATES	43780.1	39094.5	34769.5	38026.8	31200.8	26306.9	27873.8

Source: Illinois Crop Reporting Service, 1988 Illinois Agriculture Statistics

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INFORMATION SHEET #2

Breed Registry Associations

Class of Animal	Breed	Association and Address
Beef and dual-purpose cattle	Angus	American Angus Assn. 3201 Frederick Blvd. St. Joseph, MO 64501
	Ankins	Ankina Breeders 5803 Oakes Road Clayton, OH 45315
	Akoie-Watusi	Ankole-Watusi International Registry Star Route 45 Hebron, ND 58638
	Barzona	Barzona Breeders Assn. of America P.O. Box 631 Prescott, AZ 86302
	Beefalo	American Beefalo Assn., Inc. 116 Executive Park Louisville, KY 40207
	Beef Friesian	Beef Friesian Society 210 Livestock Exchange Bldg. 4701 Marion Street Denver, CO 80216
	Beefmaster	Beefmaster Breeders Universal Suite 350, G.P.M. South Tower 800 N.W. Loop 410 San Antonio, TX 78216
		Foundation Beefmaster Assn. Livestock Exchange Bldg. Suite 200 4700 Marion Street Denver, CO 80216
		National Beefmaster Assn. 817 Sinclair Bldg. Fort Worth, TX 76102
	Belted Galloway	Belted Galloway Society, Inc. P.O. Box 5 Summitville, OH 43962
	Blonde d'Aquitaine	American Blonde d'Aquitaine Assn. Route B, Box 230 Grandview, ID 83624
	Braford	International Braford Assn., Inc. P.O. Box 1030 Ft. Pierce, FL 33450
	Brahman	American Brahman Breeders Assn. 1313 La Concha Lane Houston, TX 77054

Beef and dual-purpose cattle (con't)	Brangus	International Brangus Breeders Assn., Inc. 9500 Tioga Drive San Antonio, TX 78230
	Charolais	American-International Charolais Assn. 1610 Old Spanish Trail Houston, TX 77054
	Chianina	American Chianina Assn. P.O. Box 890 Platte City, MO 64079
	Devon	Devon Cattle Assn., Inc. P.O. Box 628 Uvalde, TX 78801
	Dexter	American Dexter Cattle Assn. 707 W. Water Street Decorah, IA 52101
	Galloway	American Galloway Breeders Assn. Route 1, Box 106A Athol, ID 83801
		Galloway Cattle Society of America Hennepin, IL 61327
	Gelbvieh	American Gelbvieh Assn. 5001 National Western Drive Denver, CO 80216
	Hereford	American Hereford Assn., The 715 Hereford Drive Kansas City, MO 64105
	Limousin	North American Limousin Foundation 100 Livestock Exchange Bldg. 4701 Marion Street Denver, Co 80216
	Maine-Anjou	American Maine-Anjou Assn. 564 Livestock Exchange Bldg. 1600 Genesee Street Kansas City, MO 64102
	Marchigiana	American International Marchigiana Society P.O. Box 342 Lindale, TX 75551
	Milking Shorthorn	American Milking Shorthorn Society 313 S. Glenstone Springfield, MO 65802
	Murray Grey	American Murray Grey Assn. 1222 North 27th Street Billings, MT 59107
	Normande	American Normande Assn. P.O. Box 350 Kearney, MO 64060

Beef and dual-purpose cattle (con't)	Pinzgauer	American Pinzgauer Assn. P.O. Box 1003 Norman, OK 73070
		Canadian Pinzgauer Assn. No. 108 Stockmans Centre 2116 27th Avenue N.E. Calgary, Alberta, Canada T2E 7A6
	Polled Hereford	American Polled Hereford Assn. 4700 East 63rd Street Kansas City, MO 64130
	Polled Shorthorn	American Polled Shorthorn Society 8288 Hascall Street Omaha, NE 68124
	Ranger	Ranger Cattle Company Box 21300, North Pecos Station Denver, CO 80221
	Red Angus	Red Angus Assn. of America 4201 I-35 North Denton, TX 76201
	Red Brangus	American Red Brangus Assn. P.O. Box 1326 Austin, TX 78767
	Red Poll	American Red Poll Assn. Box 35519 Louisville, KY 40232
	Romagnoia	Canadian Romark Assn. Box 177 Jarvie, Alberta Canada T0G 1H0
	Salers	American Salers Assn. P.O. Box 30 Weiser, ID 83672
	Santa Gertrudis	Santa Gertrudis Breeders International P.O. Box 1257 Kingsville, TX 78363
	Scotch Highland	American Scotch Highland Breeders Assn. P.O. Box 81 Remer, MN 56672
	Shorthorn	American Shorthorn Assn. 8288 Hascall Street Omaha, NE 68124
	Simmental	American Simmental Assn. 1 Simmental Way Bozeman, MT 59715
	South Devon	North American South Devon Assn. P.O. Box 68 Lynnville, IA 50153

Beef and dual-purpose cattle (con't)	South Devon (con't)	International South Devon Assn. P.O. Box 68 Lynnville, IA 50153
	Sussex	Sussex Cattle Assn. of America P.O. Drawer AA Refugio,TX 78377
	Tarentaise	American Tarentaise Assn. 123 Airport Road Ames, IA 50010
	Texas Longhorn	Texas Longhorn Breeders Assn. of America 3701 Airport Freeway Fort Worth, TX 76111
	Welsh Black	United States Welsh Black Cattle Assn. Route 1 Wahkon, MN 56386
Dairy Cattle	Ayshire	Ayshire Breeders Assn. 2 Union Street Brandon, VT 05733
	Brown Swiss	Brown Swiss Cattle Breeders Assn., The Box 1038 Beloit, WI 53511
	Dutch Belted	Dutch Belted Cattle Assn. of America, The P.O. Box 358 Venus, FL 33960
	Guernsey	American Guernsey Cattle Club, The 2105J S. Hamilton Road Columbus, OH 43227
	Holstein-Friesian	Holstein-Friesian Assn. of America P.O. Box 808 Brattleboro, VT 05301
	Illawarra	International Illawarra Assn. 1722JJ S. Glenstone Avenue Springfield, MO 65804
	Jersey	American Jersey Cattle Club, The P.O. Box 27310 Columbus, OH 43227
	Milking Shorthorn	American Milking Shorthorn Society 1722JJ South Glenstone Avenue Springfield, MO 65804
Sheep	Cheviot	American Cheviot Sheep Society R.R. #1 Box 100 Clarks Hill, IN 47930
	Columbia	Columbia Sheep Breeders Assn. of America P.O. Box 272 Upper Sandusky, OH 43351

Sheep (con't)	Cormo	American Cormo Sheep Assn. 18106 Woodgate Road Montrose, CO 81401
	Corriedale	American Corriedale Assn., Inc. Box 29C Seneca, IL 61360
	Cotswold	American Cotswold Record Assn. 282 Meaderboro Road Rochester, NH 03867
	Debouillet	Debouillet Sheep Breeders Assn. 300 S. Kentucky Roswell, NM 88201
	Delaine Merino	American & Delaine Merino Record Assn. 1193 Township Road 346 Nova, OH 44859
		Black Top & National Delaine Merino Sheep Assn. 290 Beech Street Muse, PA 15350
		Texas Delaine Sheep Assn. Route 1 Burnet, TX 78611
	Dorset	Continental Dorset Club, Inc. P.O. Box 577 Hudson, IA 50644
	Finnsheep	Finnsheep Breeders Assn., Inc. P.O. Box 34303 Indianapolis, IN 46234
	Hampshire	American Hampshire Sheep Assn. Box 345 Ashland, MO 65010
	Lincoln	National Lincoln Sheep Breeders Assn. R.R. #6, Box 24 Decatur, IL 62621
	Montadale	Montadale Sheep Breeders Assn., Inc. P.O. Box 44300 Indianapolis, IN 46244
	Natural Colored	Natural Colored Wool Growers Assn. Route 2, Box 2382 Davis, CA 95916
	North American Clan Forest	North American Clan Forest Asn. High Meadow Farm Ferryville, WI 54628
	North County Cheviot	American North County Cheviot Sheep Assn. 717 Fall Creek Road Longview, WA 98632

Sheep (con't)	Oxford	American Oxford Down Record Assn. Route #4 Ottawa, IL 61350
	Panama	American Panama Registry Assn. Route #1 Jerome, ID 83338
	Polypay	American Polypay Sheep Assn. 1934 East Rua Bronco Sandy, UT 84092
	Rambouillet	American Rambouillet Sheep Breeders Assn., The 2709 Sherwood Way San Angelo, TX 76901
	Romney	American Romney Breeders Assn. 4375 N.E. Weslinn Drive Corvallis, OR 97333
	Shropshire	American Shropshire Registry Assn., Inc P.O. Box 1970 Monticello, IL 61856
	Southdown	American Southdown Breeders Assn. Route #4, Box 14B Bellefonte, PA 16283
	Suffolk	American Suffolk Sheep Assn. 55 East 100 North Logan, UT 84321
		National Suffolk Sheep Assn. P.O. Box 324 Columbia, MO 65201
	Targhee	U.S. Targhee Sheep Assn. P.O. Box 40 Absarokee, MT 59001
	Tunis	National Tunis Sheep Registry R.D. 1 Wayland, NY 14572
Goats	Angora	American Angora Goat Breeders Assn. P.O. Box 195 Rocksprings, TX 78880
Dairy Goats	All Breeds	American Dairy Goat Assn. P.O. Box 865 Spindale, NC 28160
		American Goat Society, Inc. Route 2, Box 112 DeLeon, TX 76444
		International Dairy Goat Registry, Inc. Rt 2, Box 365 Dublin, TX 76446

Dairy Goats (con't)		National Pygmy Goat Assn. Fern Avenue Amesbury, MA 01913
Swine	Berkshire	American Berkshire Assn. 601 W. Monroe Street Springfield, IL 62704
	Chester White	Chester White Swine Record Assn. P.O. Box 228 Rochester, IN 46975
	Duroc	United Duroc Swine Registry 1803 W. Detweiller Drive Peoria, IL 61615
	Hampshire	Hampshire Swine Registry 1111 Main Street Peoria, Il 61606
	Hereford	National Hereford Hog Record Assn. Route 1, Box 37 Flandreau, SD 57028
	Landrace	American Landrace Assn., Inc. Box 647 Lebanon, IN 46052
	Poland China	Poland China Record Assn. 368 West Douglas, Box B Knoxville, IL 61448
	Spotted	National Spotted Swine Record, Inc. 110 West Main Street Bainbridge, IN 46105
	Tamworth	Tamworth Swine Assn. 2656 Homer Road Winchester, OH 45697
	Yorkshire	American Yorkshire Club, Inc. Box 2417 West Lafayette, IN 47906
Light horses	American Bashkir Curly	American Bashkir Curly Registry P.O. Box 453 Ely, NV 89301
	American Creme Horse	Worldwide Horse Registry for American White and American Creme Box 79 Crabtree, OR 97335
	American Fox Trotting Horse	American Fox Trotting Horse Breed Assn., Inc. P.O. Box 666 Marshfield, MO 65706
	American Mustang	American Mustang Assn., Inc. P.O. Box 338 Yucaipa, CA 92399

Light horses (con't)	American Paint Horse	American Paint Horse Assn. P.O. Box 18519 Fort Worth, TX 76118
	American Part-Blooded	American Part-Blooded Horse Registry 4120 E. River Drive Portland, OR 97222
	American Saddlebred Horse	American Saddlebred Horse Assn. 929 South Fourth Street Louisville, KY 40203
	American White Horse	Worldwide Horse Registry for American White and American Creme Box 79 Crabtree, OR 97335
	Andalusian	American Andalusian Assn. P.O. Box 1290 Silver City, NM 88061
	Appaloosa	Appaloosa Horse Club, Inc. P.O. Box 8403 Moscow, ID
	Arabian	Arabian Horse Registry of America, Inc. 3435 South Yosemite Denver, CO 80231
	Buckskin	American Buckskin Registry Assn., Inc. P.O. Box 1125 Anderson, CA 96007
		American Buckskin Horse Assn., Inc. P.O. Box 357 St. John, IN 46373
		International Buckskin Horse Assn., Inc. P.O. Box 357 St. John, IN 46373
	Chickasaw	Chickasaw Horse Assn., Inc. The P.O. Box 607 Love Valley, NC 28677
		National Chickasaw Horse Assn. Route 2 Clarinda, IA 51232
	Cleveland Bay	Cleveland Bay Assn. of America Box 182 Hopewell, NJ 08525
	Galiceno	Galiceno Horse Breeders Assn., Inc. 111 East Elm Street Tyler, TX 75702
	Hackney	American Hackney Horse Society P.O. Box 174 Pittsfield, IL 62363
	Half-Arabian and Anglo-Arabian	International Arabian Horse Assn. 224 E. Olive Avenue Burbank, CA 91503

Light horses (con't)	Half-bred Thoroughbred	American Remount Assn., Inc. P.O. Box 1066 Perris, CA 92370
	Hanoverian	American Hanoverian Society, The 809 West 106th Street Carmel, IN 46032
	Hungarian Horse	Hungarian Horse Assn. Bitterroot Stock Farm Hamilton, MT 59840
	Lipizzan	Lipizzan Assn. of America Woolworth Tower New York, NY 10279
	Missouri Fox Trotting Horse	Missouri Fox Trotting Horse Breed Assn., Inc. P.O. Box 637 Ava, MO 65608
	Morab	Morab Horse Registry of America P.O. Box 143 Clovis, CA 93612
	Morgan	American Morgan Horse Assn., Inc. Box 1 Westmoreland, NY 13490
	Norwegian Fjord	Norwegian Fjord Assn. of North America 29645 N. Callahan Road Round Lake, IL 60073
	Palomino	Palomino Horse Assn., Inc., The P.O. Box 324 Jefferson City, MO 65102
		Palomino Horse Breeders of America P.O. Box 249 Mineral Wells, TX 76067
	Paso Fino	American Paso Fino Horse Assn., Inc. 907 Penn Avenue Pittsburgh, PA 15221
		Paso Fino Owners and Breeders Assn., Inc. P.O. Box 764 Columbus, NC 28722
	Peruvian Paso	American Assn. of Owners & Breeders of Peruvian Paso Horses P.O. Box 2035 California City, CA 93505
		Peruvian Paso Horse Registry of North America P.O. Box 816 Guerneville, CA 95446
	Pinto Horse	Pinto Horse Assn. of America, Inc. 7525 Mission Gorge Road, Suite C San Diego, CA 92120

Light horses (con't)	Quarter Horse	American Quarter Horse Assn. 2736 W. 10th Street Amarillo,TX 79168
		Standard Quarter Horse Assn. 4390 Fenton, #206 Denver, CO 80212
	Rangerbred	Colorado Ranger Horse Assn., Inc. 7023 Eden Mill Road Woodbine, MD 21797
	Spanish Barb	Spanish Barb Breeders Assn. P.O. Box 7479 Colorado Springs, CO 80907
	Standardbred	United States Trotting Assn. 750 Michigan Avenue Columbus, OH 43215
		National Trotting & Pacing Assn., Inc. 575 Broadway Hanover, PA 17331
	Tennessee Walking Horse	Tennessee Walking Horse Breeders and Exhibitors' Assn. of America P.O. Box 286 Lewisburg, TN 37091
	Thoroughbred	Jockey Club, The 380 Park Avenue New York, NY 10017
	Ysabella	Ysabella Saddle Horse Assn., Inc. c/o Prairie Edge Farm Route #3 Williamsport, IN 47993
Ponies	American Gotland Horse	American Gotland Horse Assn. P.O. Box 263 Jenks, OK 74037
	American Walking Pony	American Walking Pony Assn. Route 5, Box 88 Upper River Road Macon, GA 31201
	Connemara Pony	American Connemara Pony Society R.D.1 Hoshiekon Farm Foshen, CN 06756
	Miniature Horse	International Miniature Horse Registry Box 907 Palos Verdes, CA 90274
	National Appaloosa Pony	National Appaloosa Pony, Inc. Box 206 Gaston, IN 47342

Ponies (con't)	Pony of the Americas	Pony of the Americas Club, Inc. P.O. Box 1447 Mason City, IA 50401
	Shetland Pony	American Shetland Pony Club P.O. Box 435 Fowler, IN 47944
	Welara	American Welara Pony Society Box 401 Yucca Valley, CA 92284
	Welsh Cob	Welsh Cob Society of America 225 Head of the Bay Road Buzzards Bay, MA 02532
	Welsh Pony	Welsh Pony Society of America Box 2977 Winchester, VA 22601
Draft Horses	American Cream	American Cream Horse Assn. Route 1 Hubbard, IA 50122
	Belgian	Belgian Draft Horse Corporation of America P.O. Box 335 Wabash, IN 46992
	Clydesdale	Clydesdale Breeders Assn. of the United States Route 1, Box 131 Pecatonica, IL 61063
	Percheron	Percheron Horse Assn. of America P.O. Box 141 Fredericktown, OH 43019
	Shire	America Shire Horse Assn. 14410 High Bridge Road Monroe, WA 98272
	Suffolk	American Suffolk Horse Assn., Inc. Route 1, Box 212 Ledbetter, TX 78946
Jacks, Donkeys, and Mules	Jack and Jennett	Standard Jack and Jennett Registry of America Sulphur Run Farm Route 1, Box 194 Elk Run, KY 42733
	Miniature Donkey	Miniature Donkey Registry of the United States, Inc. 1108 Jackson Street Omaha, NE 68102
	Donkey and Mule	American Donkey and Mule Society, Inc. Route 5, Box 65 Denton, TX 68102

NOTE: Adapted from the National Society of Livestock Record Associations, 1987.

TRANSPARENCY MASTER #1

Leading States in Livestock Industries

Jan. 1, 1988 number on farms and ranches (per1,000)

Rank	All sheep and lambs		All cattle and calves	
	State	Head	State	Head
1	Texas	1,960	Texas	13,500
2	Calif.	1,015	Kans.	5,860
3	Wyo.	865	Nebr.	5,450
4	Colo.	860	Okla.	5,050
5	S.Dak.	610	Calif.	4,600
6	Mont.	538	Iowa	4,600
7	Oreg.	490	Mo.	4,250
8	Utah	478	Wis.	4,230
9	N. Mex.	451	S.Dak.	3,500
10	Iowa	405	Minn.	2,850
11	Idaho	324	Colo.	2,700
12	Ariz.	284	Ky.	2,450

TRANSPARENCY MASTER #2

Leading States in Livestock Industries

Rank	Fed cattle marketed 1987		Total pigs saved 1987		Milk produced 1987	
	State	Head*	State	Head*	State	Lbs.∞
1	Texas	5255	Iowa	22382	Wis.	24800
2	Nebr.	4900	**Ill.**	**8674**	Calif.	17934
3	Kans.	4030	Minn.	7321	N.Y.	11362
4	Colo	2230	Ind.	6982	Minn.	10436
5	Iowa	1750	Nebr.	6342	Penn.	10183
6	**Ill.**	**825**	Mo.	5195	Mich.	5248
7	Calif.	765	N.C.	4094	Ohio	4810
8	Okla.	690	Ohio	3412	Texas	4300
9	S.Dak.	650	S.Dak.	2876	Wash.	3763
10	Minn.	540	Wis.	2426	Iowa	3550
11	Ariz.	460	Kans.	2253	Mo.	2900
12	Idaho	460	Mich.	2001	**Ill.**	**2775**

* 1,000
∞ 1,000,000

TRANSPARENCY MASTER #3

Illinois Rank in Agriculture

Cash Receipts from Farm Marketings

	Year	Unit	U.S. total or average	IL total or average	IL as % of U.S. total	IL rank among states
Crops	1987	$Million	61,057	3,903	6.4	3
Livestock	1987	$Million	75,483	2,306	3.1	9
Total	1987	$Million	136,540	6,209	4.5	5

Illinois Rank in Agriculture

Livestock, Dairy and Poultry

	Year	Unit	U.S. total or average	IL total or average	IL as % of U.S. total	IL rank among states
Cattle on farms	1/1/88	1,000 head	98,994	2,050	2.1	15
Fed cattle marketed	1987	1,000 head	22,971	825	3.6	6
Pigs saved	1987	1,000 head	87,803	8,674	9.9	2
Pigs saved per litter	1987	head	7.76	7.61	—	—
Sheep on farms	1/1/88	1,000 head	10,774	107	1.0	21
Milk production	1987	Million lbs	142,462	2,775	1.9	12
Milk per cow	1987	Lbs	13,786	13,090	—	—
Whole milk (total in manufactured products)	1987	1,000 lbs	81,944,580	1,285,902	1.6	14
Italian cheese	1987	1,000 lbs	1,799,770	40,807	2.3	6
Mozzarella and similars	1987	1,000 lbs	1,364,588	24,388	1.8	6
Total cheese	1987	1,000 lbs	5,344,223	97,779	1.8	12
Creamed cottage cheese	1987	1,000 lbs	674,538	48,935	7.3	3
Ice cream	1987	1,000 lbs	931,398	29,471	3.2	11
Chickens on farm	12/1/87	1,000 head	377,516	4,010	1.1	26
Egg production	1987	Million eggs	69,492	709	1.0	26

Illinois Rank in Agriculture

Agricultural Export Shares

	Year	Unit	U.S. total or average	IL total or average	IL as % of U.S. total	IL rank among states
All commodities	FY87	$Million	27,874	2,115	7.6	3
Feed grains and products	FY87	$Million	4,662	738	15.8	2
Soybeans and product	FY87	$Million	5,747	1,048	18.2	1
Fats, oils, and greases	FY87	$Million	417	16	3.8	8
Live animals and meat	FY87	$Million	1,630	57	3.5	8

TRANSPARENCY MASTER #6

The Livestock Industry in Illinois

A. Number of Head in Illinois (Thousands)

	1946	1956	1966	1976	1986
1. All Cattle	3176	3989	3732	3200	2470
2. Hogs	6337	6348	6275	6500	5300
3. Sheep	472	523	359	195	109
4. Chickens	25761	17582	10142	7800	3270

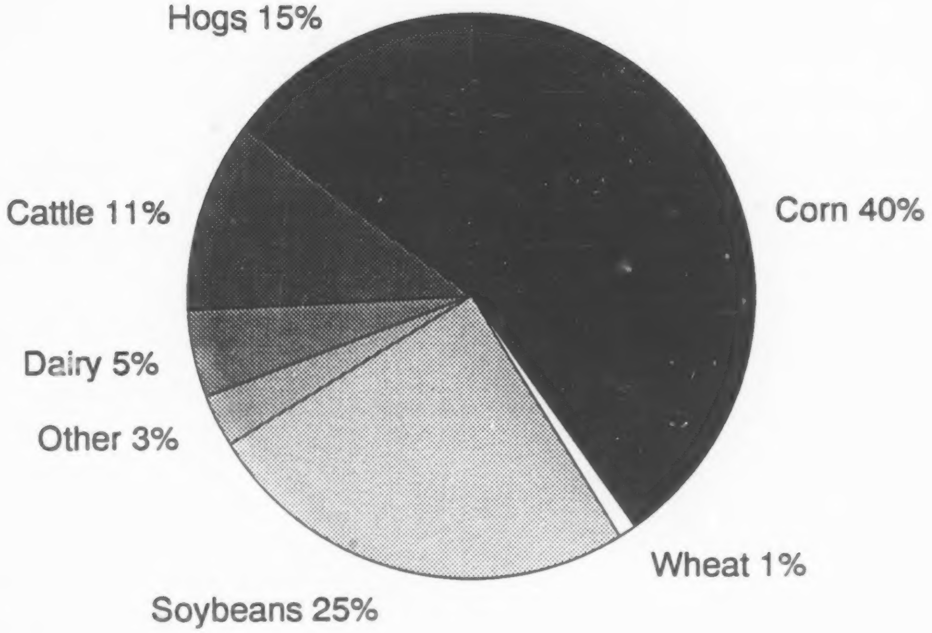
B. Value of Head in Illinois ($Million)

	1946	1956	1966	1976	1986
1. All Cattle	276.3	382.9	518.1	528.0	1012.7
2. Hogs	160.9	118.7	283.6	299.0	477.5
3. Sheep	5.2	7.1	6.1	5.3	8.8
4. Chickens	30.1	19.3	10.6	11.7	6.1

Source: Illinois Agricultural Statistics, 1946-1986
Illinois Cooperative Reporting Service
Springfield, IL

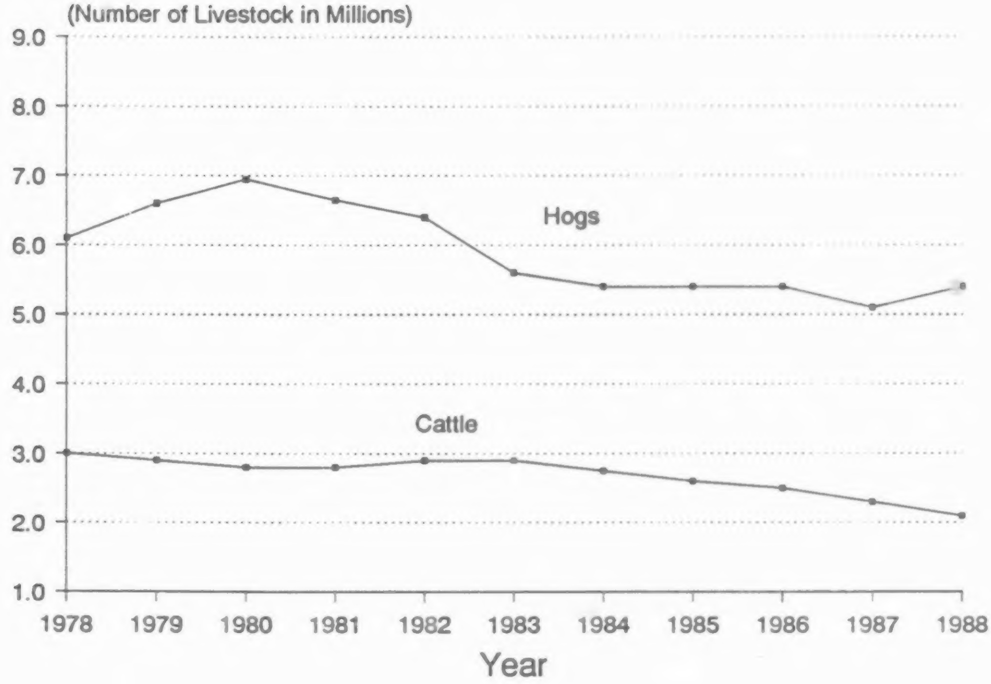
TRANSPARENCY MASTER #7

Illinois Cash Farm Income by Commodities 1986



TRANSPARENCY MASTER #8

Trends in Illinois Livestock Production



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TRANSPARENCY MASTER #9

Counties Leading in Livestock Inventory — January 1, 1988

Beef Cows

County	Number
Jo Daviess	16,900
Fulton	16,600
Knox	16,600
Pike	15,700
Adams	14,900
Hancock	13,200
Mercer	11,900
Warren	10,900
Henry	10,800
McDonough	10,200

Milk Cows

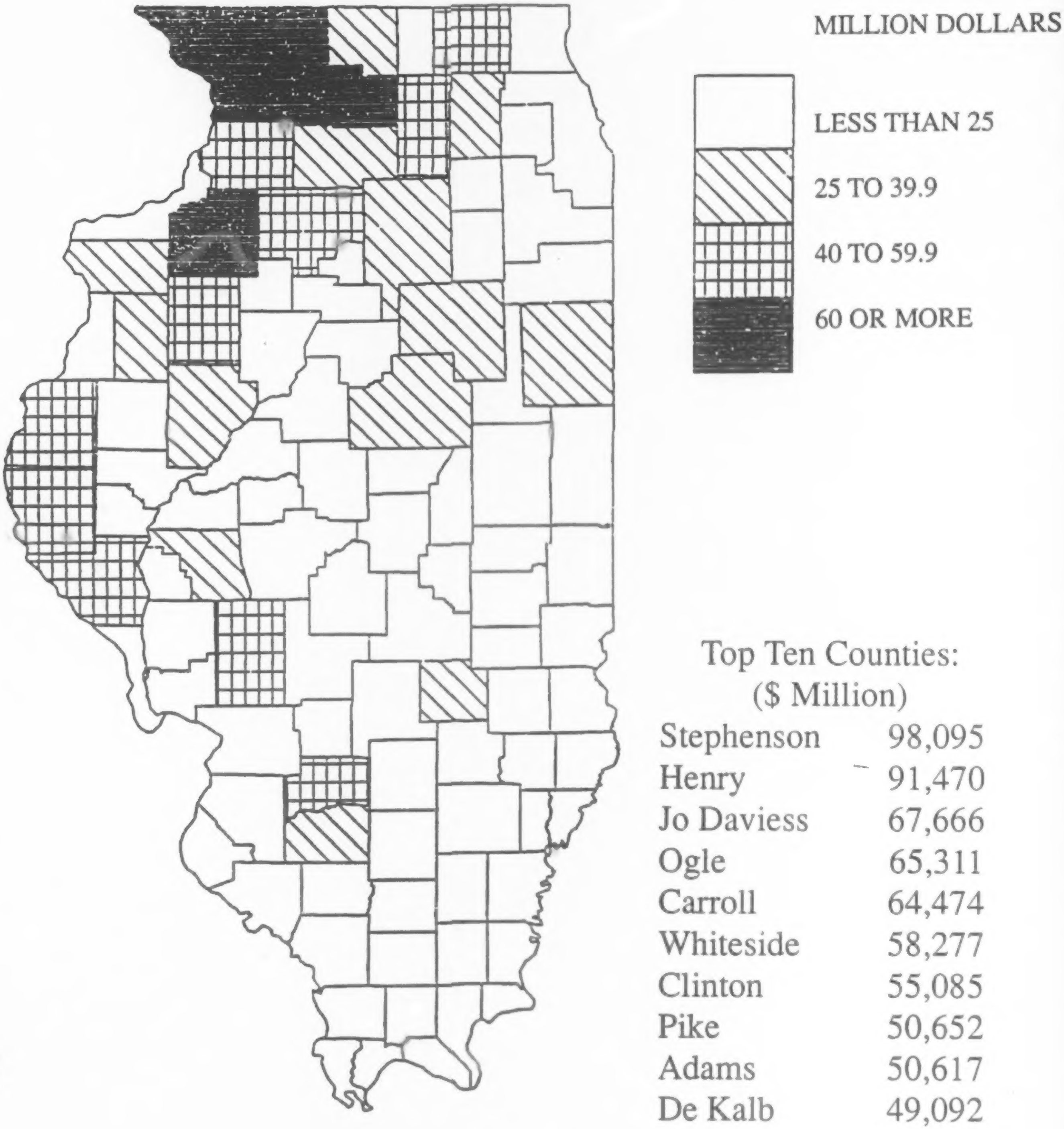
County	Number
Stephenson	32,400
Jo Daviess	20,500
Clinton	19,200
McHenry	13,800
Washington	9,100
Boone	6,900
Effingham	6,500
Winnebago	6,300
Carroll	6,200
Ogle	5,300

Stock Sheep

County	Number
DeKalb	3,700
Henry	3,400
Ogle	3,400
LaSalle	2,900
Bureau	2,800
Woodford	2,600
Stephenson	2,500
Adams	2,300
McDonough	2,300
McLean	2,300
Macoupin	2,300

TRANSPARENCY MASTER #10

Livestock Cash Receipts — 1986

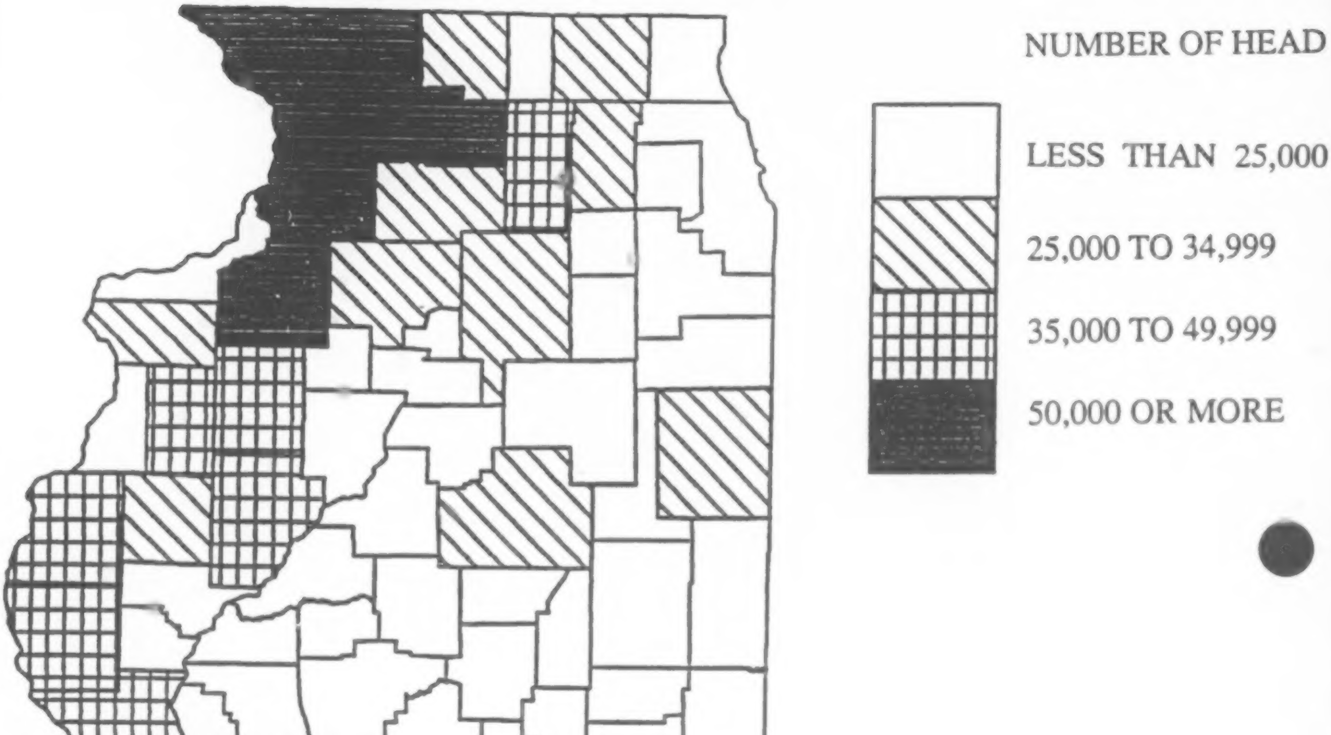

MILLION DOLLARS
LESS THAN 25
25 TO 39.9
40 TO 59.9
60 OR MORE

Top Ten Counties:
($ Million)

Stephenson	98,095
Henry	91,470
Jo Daviess	67,666
Ogle	65,311
Carroll	64,474
Whiteside	58,277
Clinton	55,085
Pike	50,652
Adams	50,617
De Kalb	49,092

TRANSPARENCY MASTER #11

All Cattle Inventory — January 1, 1988

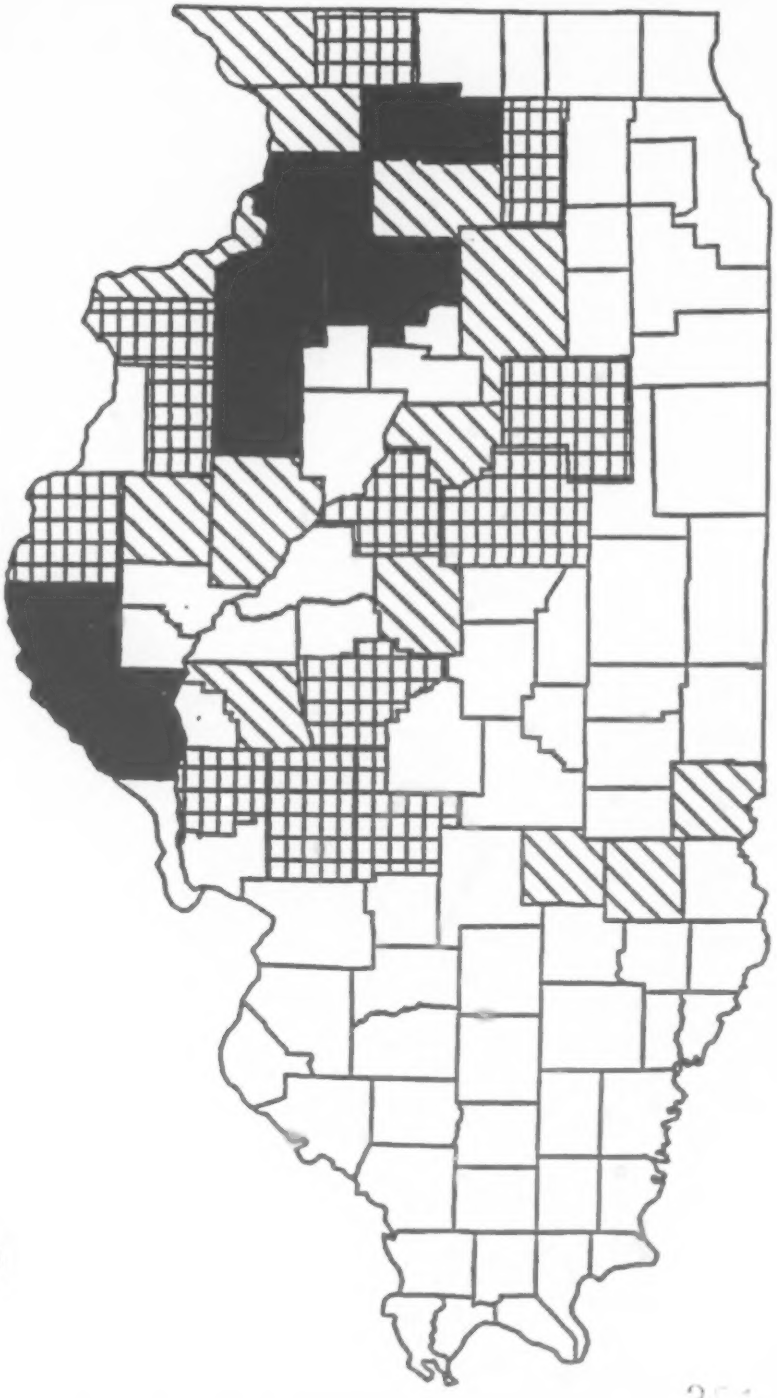

NUMBER OF HEAD
LESS THAN 25,000
25,000 TO 34,999
35,000 TO 49,999
50,000 OR MORE

Top Ten Counties:
(Number of Head)

Stephenson	80,000
Jo Daviess	76,800
Ogle	76,800
Carroll	60,200
Henry	58,600
Whiteside	52,800
De Kalb	46,900
Clinton	45,400
Pike	43,200
Hancock	41,200

TRANSPARENCY MASTER #12

All Hog Inventory — December 1, 1987



NUMBER OF HEAD

☐ LESS THAN 60,000

▨ 60,000 TO 79,999

▦ 80,000 TO 114,999

■ 115,000 OR MORE

Top Ten Counties:
(Number of Head)

Henry	306,500
Pike	191,300
Adams	167,600
Knox	161,600
Bureau	121,500
Ogle	117,000
Whiteside	115,300
Mercer	110,400
Warren	109,600
Stephenson	109,100

TRANSPARENCY MASTER #13

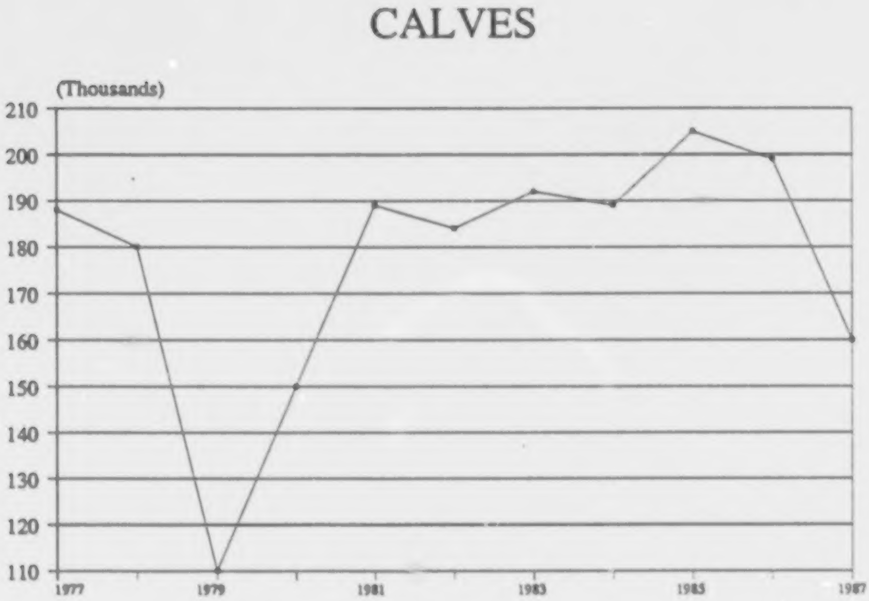
Dairy Cattle in Illinois

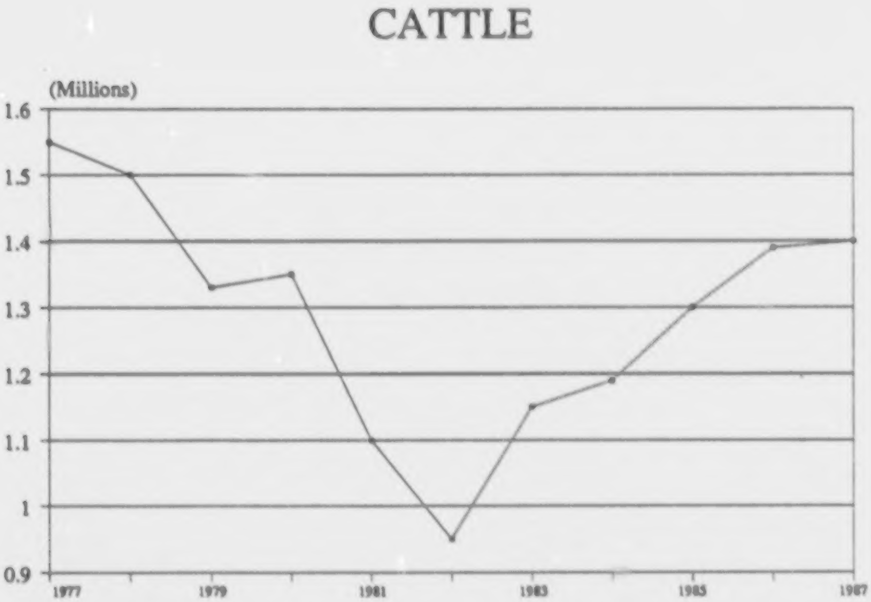
Number on Farms, Jan. 1,

District	1987	1988
Northwest	82,800	81,100
Northeast	34,000	33,200
West	6,000	5,900
Central	5,800	5,700
East	9,000	8,400
West Southwest	16,100	15,200
East Southeast	19,200	19,300
Southwest	38,900	38,000
Southeast	3,200	3,200
Total in Illinois	215,000	210,000

TRANSPARENCY MASTER #14

Cattle and Calf Slaughter — 1977-1987

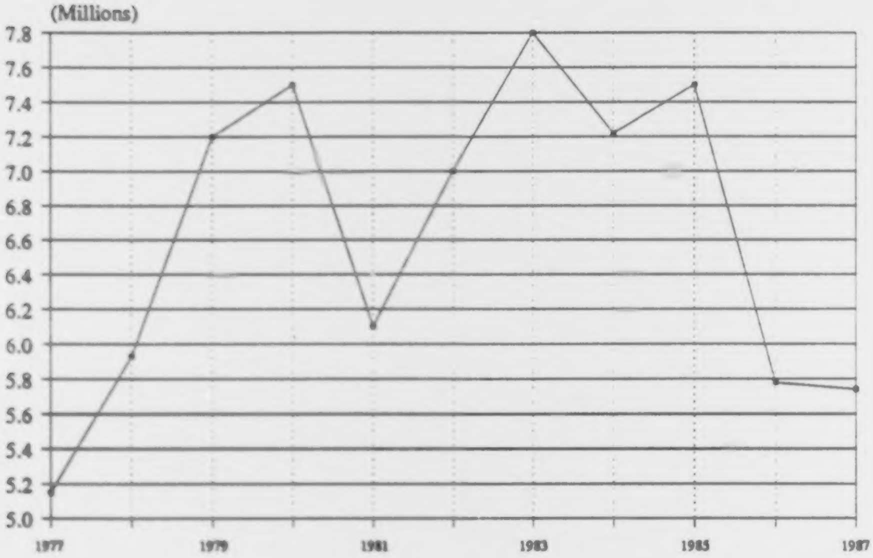




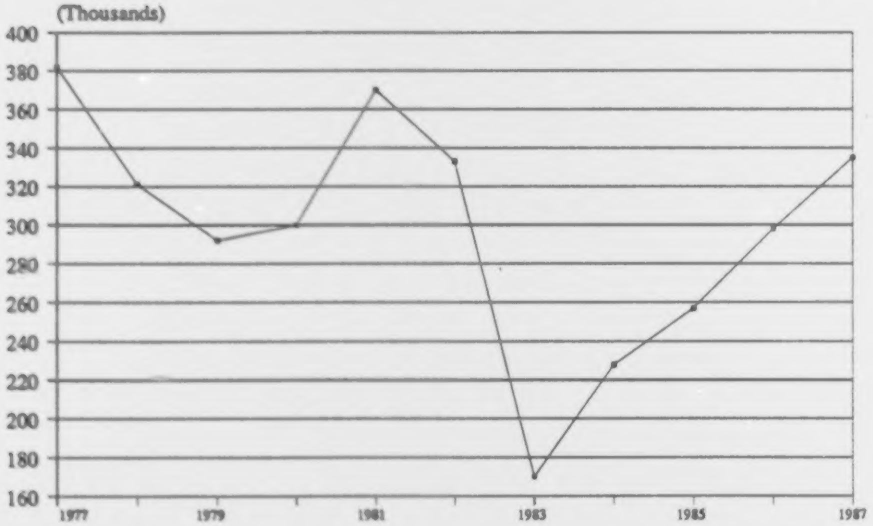
TRANSPARENCY MASTER #15

Hog, Sheep, and Lambs Slaughter
(1977-1987)

HOGS



SHEEP AND LAMBS



STUDENT ACTIVITIES

STUDENT WORKSHEET #1 — Animal Terms

STUDENT WORKSHEET #2 — Illinois Regions

STUDENT WORKSHEET #3 — Graphing Enterprise Numbers

STUDENT WORKSHEET #4 — Enterprise Questions

For additional activities, teachers may refer to the "Suggested Teaching Activities and Procedures" section in the Instructor's Guide.

STUDENT WORKSHEET #1

Animal Terms

Define the Following Terms:

1. Barrow ____________________
2. Boar ____________________
3. Broiler ____________________
4. Bull ____________________
5. Cockerel ____________________
6. Commodity ____________________
7. Corn-Hog Ratio ____________________
8. Cow ____________________
9. Diversified ____________________
10. Ewe ____________________
11. Fall Lamb ____________________
12. Feeders ____________________
13. Fryer ____________________
14. Gilt ____________________
15. Heifer ____________________
16. Hen ____________________
17. Production Cycle ____________________
18. Pullet ____________________
19. Ram ____________________
20. Sow ____________________
21. Spring Lamb ____________________
22. Stag ____________________
23. Steer ____________________
24. Trends ____________________
25. Wether ____________________
26. Yearlings ____________________

STUDENT WORKSHEET #1 — Key

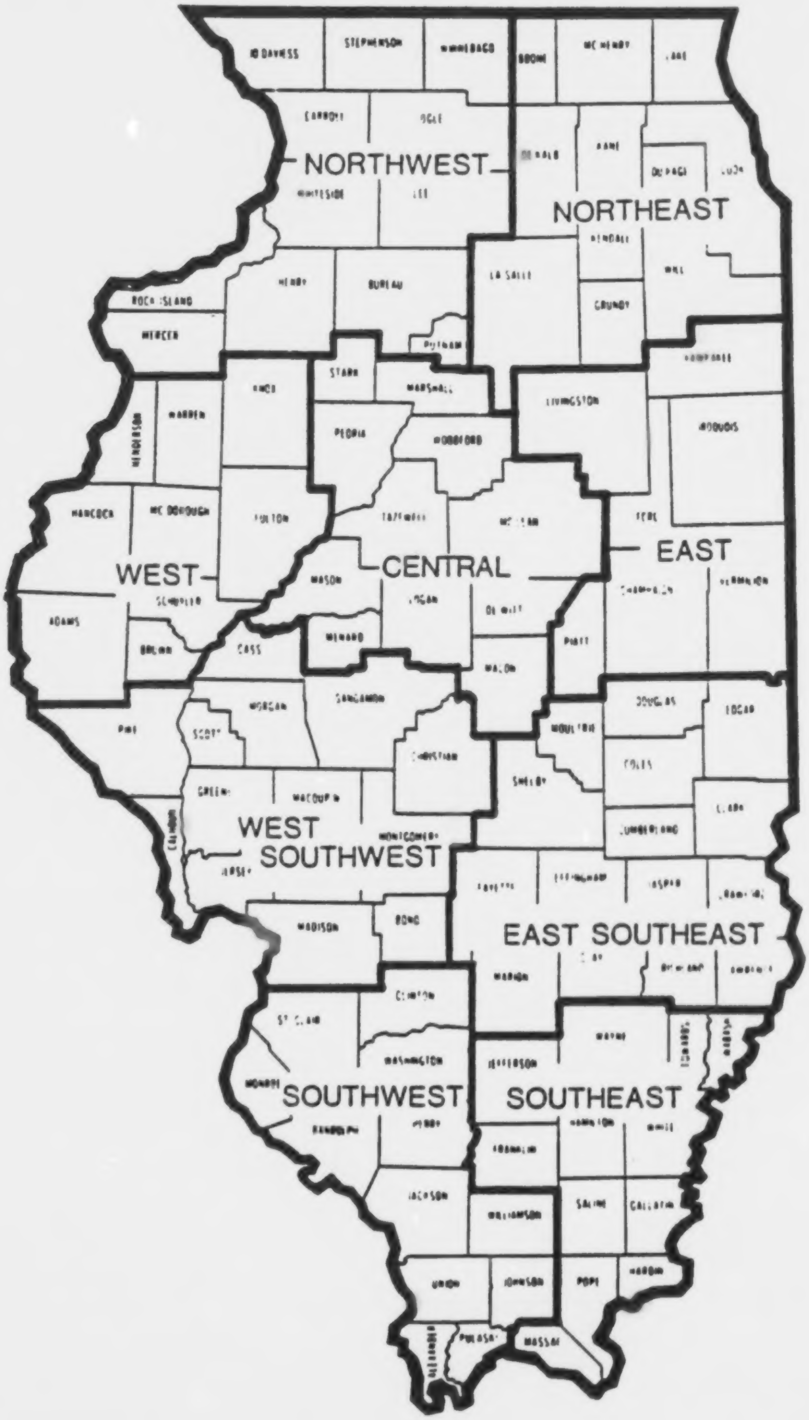
Animal Terms

1. Barrow — *a male swine that has been castrated at an early age*
2. Boar — *a mature uncastrated male swine*
3. Broiler — *a young chicken 8 - 10 weeks of age, raised for meat*
4. Bull — *a male of the bovine species (cattle)*
5. Cockerel — *a male fowl less than one year of age*
6. Commodity — *a product of agriculture, i.e. beef, pork, soybeans, etc*
7. Corn-Hog Ratio — *value of bushels of corn required to equal value of 100 lbs. of pork; ratio of price of corn to price of pork*
8. Cow — *a female bovine that shows evidence of having calved*
9. Diversified — *production of several different kinds of livestock*
10. Ewe — *a female sheep*
11. Fall Lamb — *a lamb born in the spring and usually sold in the fall*
12. Feeders — *animals grown to a determined size or weight and to be placed in a feedlot and finished to a determined grade*
13. Fryer — *a young immature bird, tender meated, smooth skin and flexible*
14. Gilt — *a young female swine that has not reproduced*
15. Heifer — *a young female bovine that has not reproduced*
16. Hen — *a mature female chicken*
17. Production Cycle — *regular changes in price and production of agricultural commodities*
18. Pullet — *a female chicken less than one year of age*
19. Ram — *a mature male sheep*
20. Sow — *a mature female swine that has reproduced*
21. Spring Lamb — *a lamb born in the fall and sold in the spring before July 1*
22. Stag — *a male animal castrated after reaching sexual maturity (except horses)*
23. Steer — *a male bovine castrated before reaching sexual maturity*
24. Trends — *directions of movement of a commodity in terms of production and prices*
25. Wether — *a castrated male lamb under one year of age*
26. Yearlings — *cattle between one and two years of age*

STUDENT WORKSHEET #2

Illinois Regions

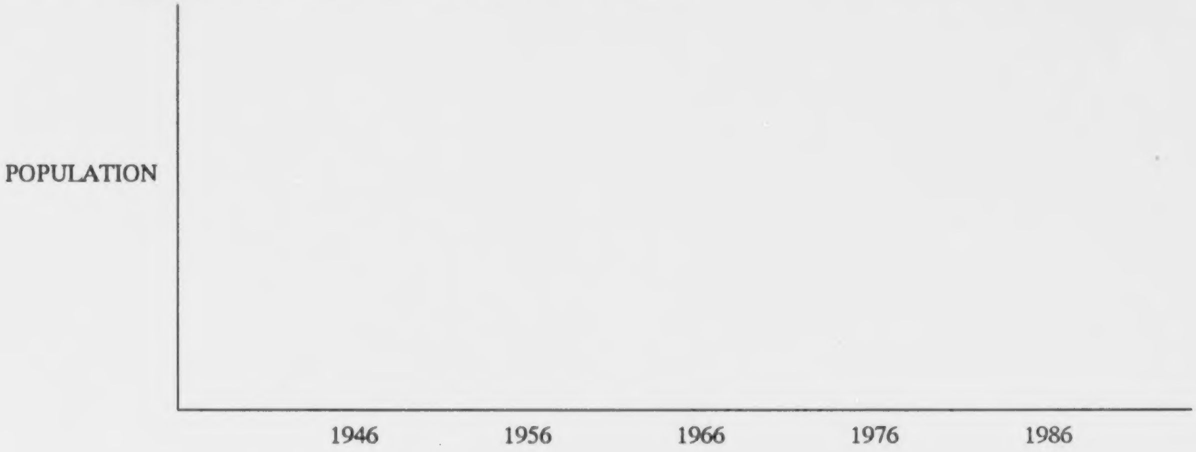
Locate on the map of Illinois the major livestock enterprise areas (beef, swine, sheep, dairy). Shade in the general regions


NORTHWEST
NORTHEAST
WEST
CENTRAL
EAST
WEST SOUTHWEST
EAST SOUTHEAST
SOUTHWEST
SOUTHEAST

STUDENT WORKSHEET #3

Graphing Enterprise Numbers

Chart a line graph showing trends (numbers) in Illinois or your county:



Trends in beef, swine, sheep, dairy, poultry, or other selected enterprises in Illinois or your county. (Use different colors for multiple graphs.)

STUDENT WORKSHEET #4

Enterprise Questions

Answer the following questions concerning animal enterprises using appropriate VAS units as resources:

A. The Swine Breeding Enterprise.

1. List nine characteristics of hogs which make them popular in Illinois.

   a.
   b.
   c.
   d.
   e.
   f.
   g.
   h.
   i.

2. The three leading countries in swine production are ______________, ______________, and ______________.

3. The largest hog producing state in the United States is ____________________.

4. The five resources necessary for swine production are:

   a.
   b.
   c.
   d.
   e.

5. When planning a swine enterprise, what questions should you consider before investing?

   a.
   b.
   c.
   d.
   e.
   f.
   g.

6. What is the formula for the hog-corn ratio and what does it mean?

7. Calculate today's hog-corn ratio and explain your result.

B. The Sheep Breeding Enterprise.

1. Identify five characteristics of the sheep enterprise which makes it popular.
   - a.
   - b.
   - c.
   - d.
   - e.

2. Identify two characteristics which are not favorable to sheep production.
   - a.
   - b.

3. Identify seven factors to consider to get maximum returns from your sheep enterprise.
   - a.
   - b.
   - c.
   - d.
   - e.
   - f.
   - g.

C. The Beef Breeding Enterprise.

1. Why is beef such a popular enterprise?
   - a.
   - b.
   - c.
   - d.

2. The average consumption of meat per person in the United States is about: __________ beef and veal, __________ lbs. pork, and __________ lamb and mutton.

3. Identify six characteristics of the beef breeding enterprise:
   - a.
   - b.
   - c.
   - d.
   - e.
   - f.

4. What factors have influenced beef production in the United States?
   - a.
   - b.
   - c.

5. What three options are available in cow-calf operations?

   a.
   b.
   c.

6. What factors can affect gross returns of a beef cow enterprise?

   a.
   b.
   c.
   d.
   e.
   f.

7. What does the beef testing program consist of?

   a.
   b.
   c.
   d.

D. The Feeder Cattle Enterprise.

1. The cost of cattle purchased for feeding is around _________ percent of the amount received at time of sale for slaughter.

2. Name some characteristics of the feeder cattle enterprise.

   a.
   b.
   c.
   d.
   e.
   f.
   g.

3. Each 100 lbs. of beef produced requires _______ lbs. of concentrates and _______ lbs. of hay.

4. What factors should be considered for cattle feeding to be profitable?

   a.
   b.
   c.
   d.

STUDENT WORKSHEET #4 — Key

Enterprise Questions

A. The Swine Breeding Enterprise.

1. List nine characteristics of hogs which make them popular in Illinois.

   a. *produce rapid returns*
   b. *prolific*
   c. *provide use for farm grains*
   d. *efficient converters of feed grains*
   e. *prices are fairly uniform across weight and grades*
   f. *price cycles are short*
   g. *high dressing percentages*
   h. *can have small investment in building and equipment*
   i. *can keep labor costs low*

2. The three leading countries in swine production are *China, Brazil,* and *United States.*

3. The largest hog producing state in the United States is *Iowa.*

4. The five resources necessary for swine production are:

   a. *capital*
   b. *land*
   c. *labor*
   d. *management*
   e. *markets*

5. When planning a swine enterprise, what questions should you consider before investing?

   a. *What kind and size of enterprise can you conduct with your resources available?*
   b. *What additional resources can I acquire?*
   c. *Can I get the needed capital?*
   d. *Do I have the needed labor?*
   e. *Do I have the management ability?*
   f. *Do I like raising hogs?*
   g. *Do I have the needed experience?*

6. What is the formula for the hog-corn ratio and what does it mean?

   $$\frac{\textit{Value of 100 lbs. of pork}}{\textit{price of one bushel of corn}}$$

   A high ratio means a profit to hog producers and a low ratio means a loss to hog producers.

7. Calculate today's hog-corn ratio and explain your result.

B. The Sheep Breeding Enterprise.

1. Identify five characteristics of the sheep enterprise which makes it popular.

   a. *two crops — lambs and wool*
   b. *initial costs are low*
   c. *low building costs*
   d. *better use of pasture*
   e. *use simple feed ratios*

2. Identify two characteristics which are not favorable to sheep production.

   a. *wool price is influenced by politics*
   b. *animals are susceptible to parasites and predatory animals*

3. Identify seven factors to consider to get maximum returns from your sheep enterprise.

   a. *all ewes should lamb*
   b. *multiple births*
   c. *low mortality*
   d. *optimum market weights and prices*
   e. *longevity*
   f. *maximum wool weights and prices*
   g. *high quality wool and mutton*

C. The Beef Breeding Enterprise.

1. Why is beef such a popular enterprise?

   a. *status symbol*
   b. *superior food*
   c. *cross-breeding practices*
   d. *efficient use of materials that would otherwise go to waste*

2. The average consumption of meat per person in the United States is about: *132 lbs.* beef and veal, *57 lbs.* pork, and *2 lbs.* lamb and mutton.

3. Identify six characteristics of the beef breeding enterprise:

   a. *uses crop residue*
   b. *provides market for grain and hay*
   c. *low investment in building and equipment*
   d. *efficient use of labor*
   e. *low death loss*
   f. *manure is a valuable by-product*

4. What factors have influenced beef production in the United States?

   a. *weather conditions*
   b. *number of cows and heifers*
   c. *prices paid and received*

5. What three options are available in cow-calf operations?

   a. *beef cow, calf sold*
   b. *beef cow, calf grown-out*
   c. *beef cow, calf fed-out*

6. What factors can affect gross returns of a beef cow enterprise?

   a. *calving percentages*
   b. *weaning weights*
   c. *quality of calves*
   d. *price of calves*
   e. *cow-calf replacement*
   f. *price of replacement cows*

7. What does the beef testing program consist of?

   a. *beef cow performance*
   b. *postweaning performance of calves*
   c. *carcass quality*
   d. *herd size performance*

D. The Feeder Cattle Enterprise.

1. The cost of cattle purchased for feeding is around *50 - 75* percent of the amount received at time of sale for slaughter.

2. Name some characteristics of the feeder cattle enterprise.

   a. *speculative*
   b. *glamor business*
   c. *use of roughages*
   d. *manure as a by-product*
   e. *use of labor*
   f. *death loss*
   g. *flexible program*

3. Each 100 lbs. of beef produced requires *551* lbs. of concentrates and *63* lbs. of hay.

4. What factors should be considered for cattle feeding to be profitable?

   a. *produce kind of beef consumer wants*
   b. *produce at low costs*
   c. *technological changes*
   d. *shifts in supply and demand*

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Classifying Animals

RELATED PROBLEM AREAS:

1. Understanding the Animal Production Industry
2. Understanding Animal Anatomy and Physiology
3. Understanding Animal Breeding and Reproduction
4. Maintaining Animal Health
5. Meeting the Environmental Requirements of Animals

PREREQUISITE PROBLEM AREA(S)

1. Identifying Basic Principles of Animal Science (Central Core Cluster)

LEVEL: Preparatory

OCCUPATIONAL TASKS ADDRESSED:

Agricultural Business and Management Cluster

Duty A: Formulating Livestock Feeding Programs

1. Evaluate livestock production records

Duty D: Marketing Animals and Animal Products

1. Sort and mark animals for market

Duty N: Breeding, Handling, and Caring for Animals

1. Evaluate animals for registry

STATE GOALS FOR LEARNING

In planning the instruction for this problem area, teachers can promote the development of several student learning objectives which are related to the State Goals for Learning in Biological and Physical Sciences. These objectives are listed on the Learning Assessment Plan forms included on the following page(s). Those learning objectives marked with an asterisk (*) are taken from the sample lists provided by the Illinois State Board of Education.

Illinois Agricultural Core Curriculum
Agricultural Education 124 Mumford Hall 1301 W. Gregory Drive University of Illinois Urbana, IL 61801

Director: Dale A. Law, Ed.D.
Principal Investigator: Jerry D. Pepple, Ed.D.
Research Assistant: Robert E. Petrea

Illinois Agricultural Core Curriculum Rev.

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date ____________
☐ Original submission ☐ Revision
Page ____ of ____

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☒ Sciences ☐ Physical Development/Health

(Affix label or complete district information.)

COUNTY	DISTRICT	ESC

District Name
City

II. STATE GOAL FOR LEARNING
As a result of their schooling, students will have a working knowledge of the concepts and basic vocabulary of biological, physical, and environmental sciences and their application to life and work in contemporary technological society.

Contact Person: ____________
Title: ____________
Phone: ( )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Compare living organisms by applying a classification scheme.					
2. Define terms integral to classifying animals.					
3. Identify the zoological classification of various animals.					
383					380

ISBE 41-78 (1/86)

Classifying Animals

Agricultural Business and Managment
Animal Science

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date ____________
☐ Original submission ☐ Revision
Page ____ of ____

I. LEARNING AREA *(check one)*
☐ Language Arts
☐ Mathematics
☒ Sciences
☐ Fine Arts
☐ Social Sciences
☐ Physical Development/Health

(Affix label or complete district information.)
COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐
District Name
City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will have a working knowledge of the social and environmental implications of technological development.

Contact Person: ____________
Title: ____________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	V. EXPECTATIONS Percent of Students Expected to Achieve Objective
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:					
*1. Understand the use of the scientific method in consumer decision making.					
2. Describe the major characteristics to consider when selecting animals.					
3. Identify common uses for various animals.					
					401

400

ISBE 41-78 (1/88)

Classifying Animals

Illinois Agricultural Core Curriculum Rev.

Agricultural Business and Managment
Animal Science

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Classifying Animals

STUDENT LEARNING OBJECTIVES

Upon completion of their study of this problem area, students will be able to:

1. Define terms integral to classifying animals.
2. Identify the zoological classification of various animals.
3. Describe the major breeds of beef cattle and evaluate typical characteristics.
4. Describe the major breeds of sheep and evaluate typical characteristics.
5. Describe the major breeds of swine and evaluate typical characteristics.
6. Describe the major breeds of dairy cattle and evaluate typical characteristics.
7. Describe the major breeds of poultry and evaluate typical characteristics.
8. Describe the major breeds of horses and evaluate typical characteristics.
9. Describe common uses for various animal species.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Classifying Animals

PROBLEMS AND QUESTIONS FOR STUDY

1. What are the major breeds of beef cattle?
2. What are the characteristics of the breeds of beef cattle?
3. Why should one know differences among beef cattle breeds?
4. What are the major breeds of sheep?
5. What are the characteristics of the breeds of sheep?
6. Why should one know the differences among sheep breeds?
7. What are the major breeds of swine?
8. What are the characteristics of the major breeds of swine?
9. Why should one know the differences among the major breeds of swine?
10. What are the major breeds of dairy cattle?
11. What are the characteristics of the major breeds of dairy cattle?
12. How can one use the information on the differences among dairy cattle breeds?
13. What are the major breeds of poultry?
14. What are the characteristics of the major breeds of poultry?
15. How can one use the information on the differences among poultry breeds?
16. What are the major breeds of horses?
17. What are the characteristics of the major breeds of horses?
18. How can one use the information on the differences among horse breeds?
19. What are the major concerns to consider when selecting animals?
20. Why are certain animals chosen for certain uses?
21. How will understanding animal breeds and selection methods help one to be a smart consumer?

INSTRUCTOR'S NOTES AND REFERENCES

400

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Classifying Animals

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES

1. Use local persons such as production facility managers and owners, cooperative extension service personnel, veterinarians, breeding services, livestock association representatives, and others for material, ideas, and equipment.

2. Use Information Sheet #1 to acquaint students with or reinforce their learning of the classification system used for animals and where the animals discussed fit in that classification scheme.

3. Conduct field trips to observe and identify breeds of animals and confirm major types.

4. Use color slides to allow students to observe differences among and compare conformations of various species of animals.

5. Use texts, VAS materials, or Instructional Materials Service Publications as student resources for Student Worksheets #1 - #6 on breeds of animals.

6. Use Information Sheet #2 as a guide for publications to be used in developing materials on horses.

7. Use texts, VAS materials, or Instructional Materials Service Publications for Student Worksheets #7 - #10 on conformation types and selecting breeding animals. Use these in conjunction with Transparency Masters #7 - #13.

8. Have students complete Student Worksheet #3 in conjunction with Transparency Masters #14 - #16 and/or other references as required.

9. Have students compile a list of cuts of meat eaten at home and use the information from Student Worksheet #13 to identify the locations of the cuts.

10. Use this problem area as a review and in preparation for a judging contest. Additional practice can be had using VAS practice filmstrips for judging and periodical journal contests such as Hoard's Dairyman.

11. Lead students in a discussion of how this problem area contributes to being an informed and knowledgeable consumer.

12. Promote the inclusion of the problem area material into SAE programs.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Classifying Animals

REFERENCES

*1. *The Stockman's Handbook.* (1983). Ensminger, M.E. Interstate Publishers, Inc, P.O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

2. *Animal Science.* (1983). Ensminger, M.E. Interstate Publishers, Inc, P.O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

3. *Beef Cattle Science.* (1976). Ensminger, M.E. Interstate Publishers, Inc, P.O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

4. *Dairy Cattle Science.* (1980). Ensminger, M.E. Interstate Publishers, Inc, P.O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

5. *Sheep and Wool Science.* (1983). Ensminger, M.E. Interstate Publishers, Inc, P.O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

6. *Swine Science.* (1983). Ensminger, M.E. Interstate Publishers, Inc, P.O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

7. *Poultry Science.* (1980). Ensminger, M.E. Interstate Publishers, Inc, P.O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

8. *Horses and Horsemanship.* (1977). Ensminger, M.E. Interstate Publishers, Inc, P.O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

*9. *Judging Livestock* (VAS Unit #U1019a); *Selecting and Purchasing Hogs* (VAS Unit #U1033b); *Breeds of Swine* (VAS Unit #U1045a); *Dairy Cattle Breeds* (VAS Unit #U1046); *Breeds of Sheep* (VAS Unit #U1049); *Using Livestock Production Records* (VAS Unit #U1061); *Selecting Beef Breeding Animals* (VAS Filmstrip #F100a); *Breeds of Beef Cattle* (VAS Filmstrip #F102); *Aberdeen Angus Judging Class, Part I* (VAS Filmstrip #F103-1.1); *Aberdeen Angus Judging Class, Part II* (VAS Filmstrip #F103-1.2); *Hereford Judging Classes* (VAS Filmstrip #F103-1.3); *Breeds of Sheep* (VAS Filmstrip #F145); *Breeds of Swine* (VAS Filmstrip #F164a); *Selecting Dairy Cattle* (VAS Filmstrip #F207a); *Breeds of Dairy Cattle* (VAS Filmstrip #F210); *Holstein Judging Classes* (VAS Filmstrip #F211-1.1); *Guernsey Judging Classes* (VAS Filmstrip #F211-2.1). Vocational Agriculture Service, College of Agriculture, University of Illinois, 1401 S. Maryland Drive, Urbana, IL 61801. (217) 333-3871.

*10. *Breeds of Beef Cattle* (Subject Matter Unit #8393); *Breeds of Swine* (Subject Matter Unit #8394); *Breeds of Sheep* (Subject Matter Unit #8395); *Breeds of Dairy Cattle* (Subject Matter Unit #8396); *Breeds and Varieties of Poultry* (Subject Matter Unit #8397); *Selecting Beef Cattle* (Subject Matter Unit #8399); *Selecting Swine* (Subject Matter Unit #8400); *Selecting Sheep* (Subject Matter Unit #8401); *Selecting Dairy Cattle* (Subject Matter Unit #8402); *Selecting Poultry* (Subject Matter Unit #8403); *Selecting Horses* (Subject Matter Unit #8404). Instructional Materials Service, P.O. Box 2588, Texas A & M University, College Station, TX 77843-2588.

11. *Horses, Horsemanship and Related Review.* (Computer Program #AP2-A6112). Hobar Publications, 1234 Tiller Lane, St. Paul, MN 55112. (612) 633-6170.

12. *The Complete Book of Horse Care* (Text #C12843N); *International Encyclopedia of Horse Breeds* (Text #C12640N); *Sam Savitt Draft Horse Chart* (Chart #C11784N); *Guide to Horses* (Chart #C7920N). NASCO, 901 Janesville, Fort Atkinson, WI 53538. (414) 563-2446 and (800) 558-9595.

13. *Horse Judging Kit* (Color slides #1-466-200J); *Horse Breeds and Color Types* (Color slides #1-462-200J). Vocational Education Publications, California Polytechnic State University, 1 Grand Avenue, San Luis Obispo, CA 93401. (800) 235-4146.

*Indicates highly recommended reference

INSTRUCTIONAL RESOURCES

These resources are intended for use by teachers in planning and teaching the materials for this problem area and may be adapted to fit the teaching method(s) used.

INFORMATION SHEET #1 — Zoological Classification of Typical Animals

INFORMATION SHEET #2 — Resources for Horse Breeds and Selection

TRANSPARENCY MASTER #1 — Parts of a Beef Animal

TRANSPARENCY MASTER #2 — Parts of a Hog

TRANSPARENCY MASTER #3 — Parts of a Sheep

TRANSPARENCY MASTER #4 — Parts of a Dairy Cow

TRANSPARENCY MASTER #5 — Parts of a Horse

TRANSPARENCY MASTER #6 — Parts of a Chicken

TRANSPARENCY MASTER #7 — Criteria to Use in Selecting Breeding Stock

TRANSPARENCY MASTER #8 — Ideal Beef Conformation

TRANSPARENCY MASTER #9 — Major Parts of a Hog

TRANSPARENCY MASTER #10 — Modern Meat Type Hogs

TRANSPARENCY MASTER #11 — Good Conformation of a Dairy Cow

TRANSPARENCY MASTER #12 — Good Conformation of a Sheep

TRANSPARENCY MASTER #13 — Some Desirable Conformation Features of a Horse

TRANSPARENCY MASTER #14 — Wholesale Cuts of a Beef Carcass

TRANSPARENCY MASTER #15 — Wholesale Cuts of Pork

TRANSPARENCY MASTER #16 — Wholesale Cuts of Lamb

INFORMATION SHEET #1

Zoological Classification of Typical Animals

Dairy and Beef:

A. Kingdom Animalia — animals collectively; the animal kingdom.
B. Phylum Chordata — one of the approximately 21 phyla of the animal kingdom, in which there is either a backbone (in the vertebrates) or the rudiment of a backbone, the chorda.
C. Class Mammalia — mammals or warm-blooded, hairy animals that produce their young alive and suckle them for a variable period on a secretion from the mammary glands.
D. Order Artiodactyla — even-toed, hoofed mammals.
E. Family Bovidae — ruminants having polycotyledonary placenta; hollow nondeciduous, up-branched horns; and nearly universal presence of a gall bladder.
F. Genus *Bos* — ruminant quadrupeds, including wild and domestic cattle, distinguished by a stout body and hollow, curved horns standing out laterally from the skull.
G. Species *Bos taurus* and *Bos indicus* — *Bos taurus* includes ancestors of the European cattle and of the majority of cattle found in the United States; *Bos indicus* is represented by the humped cattle (Zebu) of India and Africa and the Brahman breed of America.

Sheep:

A. Kingdom Animalia.
B. Phylum Chordata.
C. Class Mammalia.
D. Order Artiodactyla
E. Family Bovidae
F. Genus *Ovis* — the domestic sheep and the majority of wild sheep. The horns form a lateral spiral.
G. Species *Ovis aries* — Domesticated sheep.

Swine:

A. Kingdom Animalia.
B. Phylum Chordata.
C. Class Mammalia.
D. Order Artiodactyla.
E. Family Suidae — nonruminant ariodactyl ungulates, consisting of wild and domestic swine but, in modern classifications, excluding the peccaries.
F. Genus *Sus* — swine, formerly comprehensive but now restricted to the European wild boar and its allies, with the domestic breeds derived from them.
G. Species *Sus scrofa* and *Sus vittatus* — *Sus scrofa* is a wild hog of continental Europe from which most domestic swine have been derived. *Sus vittatus* was the chief, if not the only, race or species of East Indian pig that contributed to present-day domestic swine.

Horse:

A. Kingdom Animalia.
B. Phylum Chordata.
C. Class Mammalia.
D. Order Perissodactyla — nonruminant hoofed mammals, usually with an odd number of toes, the third digit the largest and in line with the axis of the limb. This suborder includes the horse, tapir, and rhinoceros.
E. Family Equidae — distinguished from the other existing perissodactyla (rhinoceros and tapir) by their comparatively more slender and agile build.
F. Genus *Equus* — includes horses, asses and zebras.
G. Species *Equus caballus* — the horse is distinguished from asses and zebras by the longer hair of the mane and tail, the presence of the "chestnut" on the inside of the hindleg, and by other less constant characteristics such as larger size, larger hoofs, more arched neck, smaller head, and shorter ears.

Poultry

A. Kingdom Animalia.
B. Phylum Chordata.
C. Class Aves — those animals having feathers.
D. Subclass Neornithes — modern birds (as opposed to fossil birds).
E. Suborder Carinatae — those birds with keel-like breast bones; this superorder has 2,810 genera and 8,616 species. In addition there are over 25,000 subspecies. The genus-species of domesticated birds are:

1. chicken — *Gallus domesticus*
2. duck — *Anas domestica*
3. goose — *Anser domestica*
4. guinea fowl — *Numida meleagris*
5. pigeon — *Columba domestica*
6. turkey — *Meleagris gallopavo*

INFORMATION SHEET #2

Resources for Horse Breeds and Selection

1. Vocational Education Productions. *Horse Judging Kit* - color slides #1-466-200J. *Horse Breeds and Color Types* - color slides #1-462-200J.

2. NASCO. *The Complete Book of Horse Care* - text #C12843N. *International Encyclopedia of Horse Breeds* - text #C12640N. *Sam Savitt Draft Horse Chart* - chart #C11784N. *Guide to Horses*-chart #C7920N.

3. Interstate Publishers, Inc. *Horses and Horsemanship* - text. *Stockman's Handbook*-text. *Animal Science* - text.

4. Hobar. *Horses, Horsemanship and Related Review* - computer program #AP2-A6112.

5. Agri-Farm. *Horses and Horsemanship* - manual #107. Agri-quiz: *Horses* - computer program #3013. Agri-ID-computer program #3107.

6. Vocational Agriculture Service. *Caring for the Brood Mare and Foal* - #U1041. *Horses and Horsemanship* - U1047. *Good Horsemanship* - F150. *Horse Feeding and Nutrition* - F152. *Horse Transparencies* - F150.

7. Instructional Materials Service. *Breeds of Horses* - #8398. *Selecting Horses*- #8404. *Methods of Identifying Livestock*- #8645-F.

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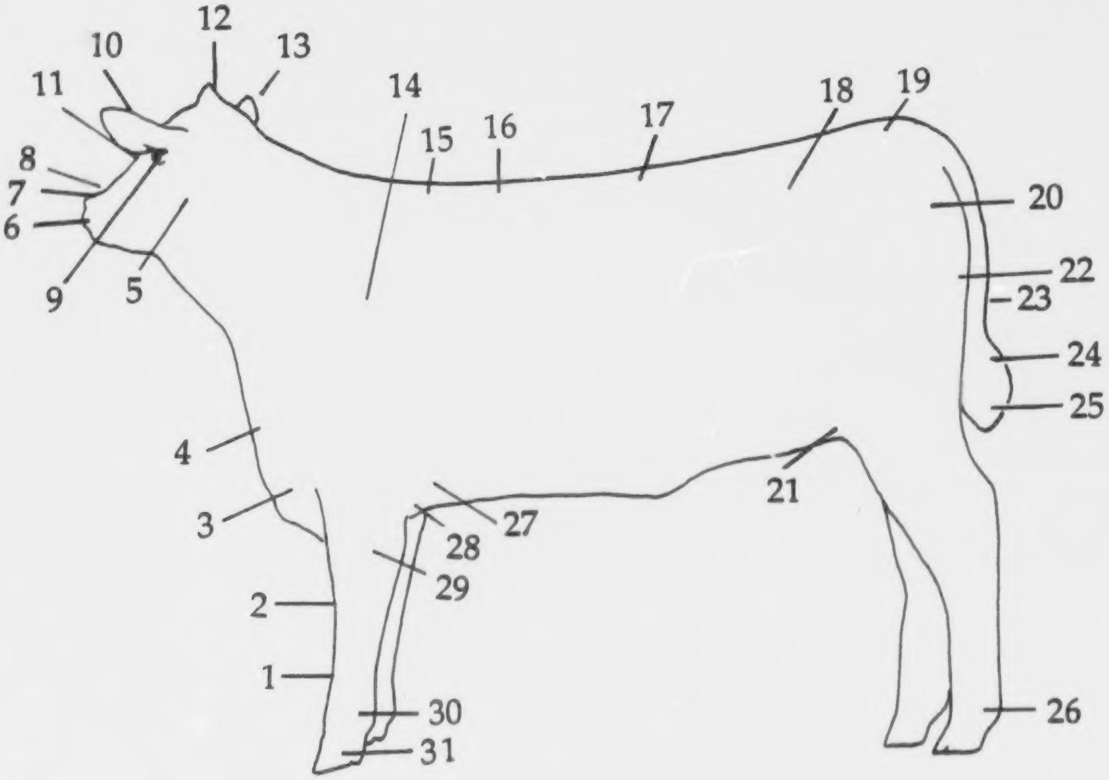
TRANSPARENCY MASTER #1

Parts of a Beef Animal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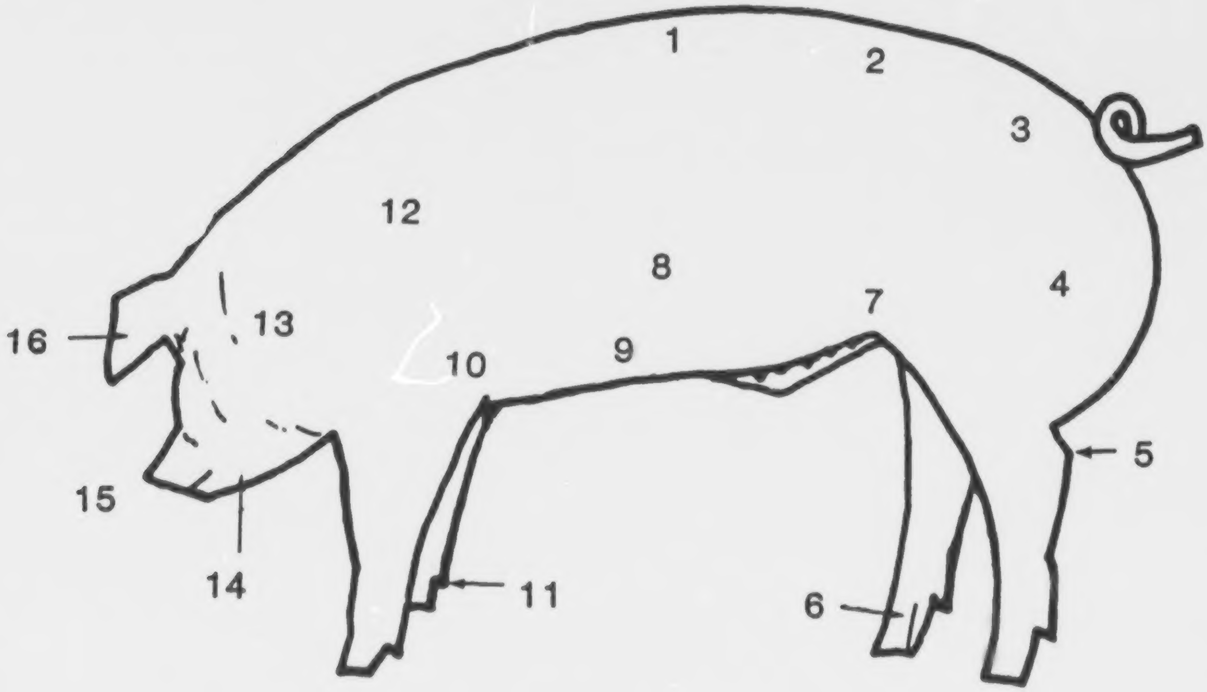
TRANSPARENCY MASTER #2

Parts of a Hog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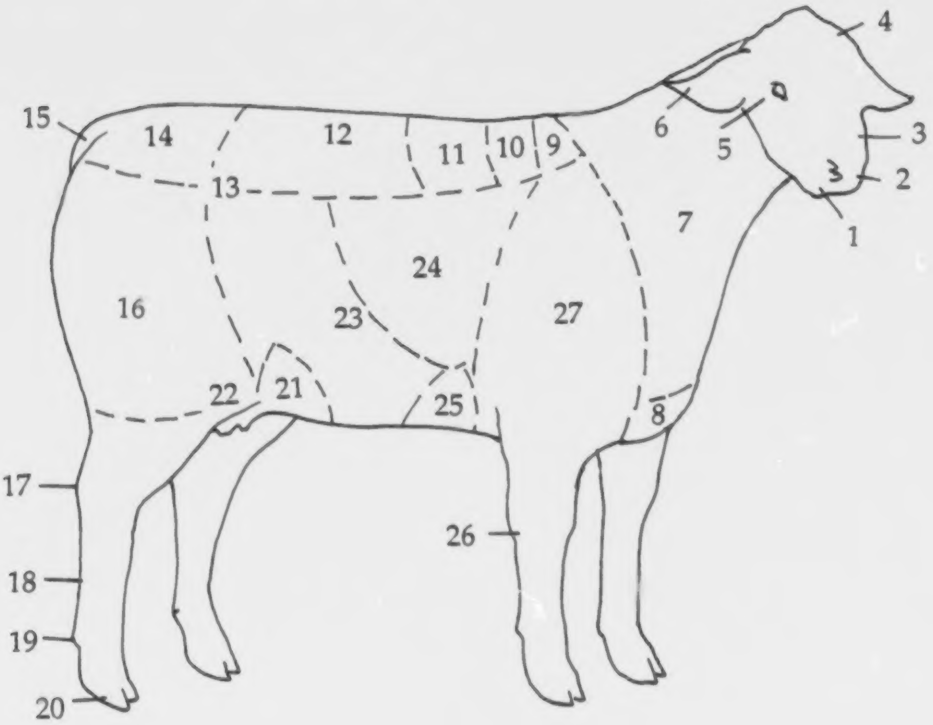
TRANSPARENCY MASTER #3

Parts of a Sheep



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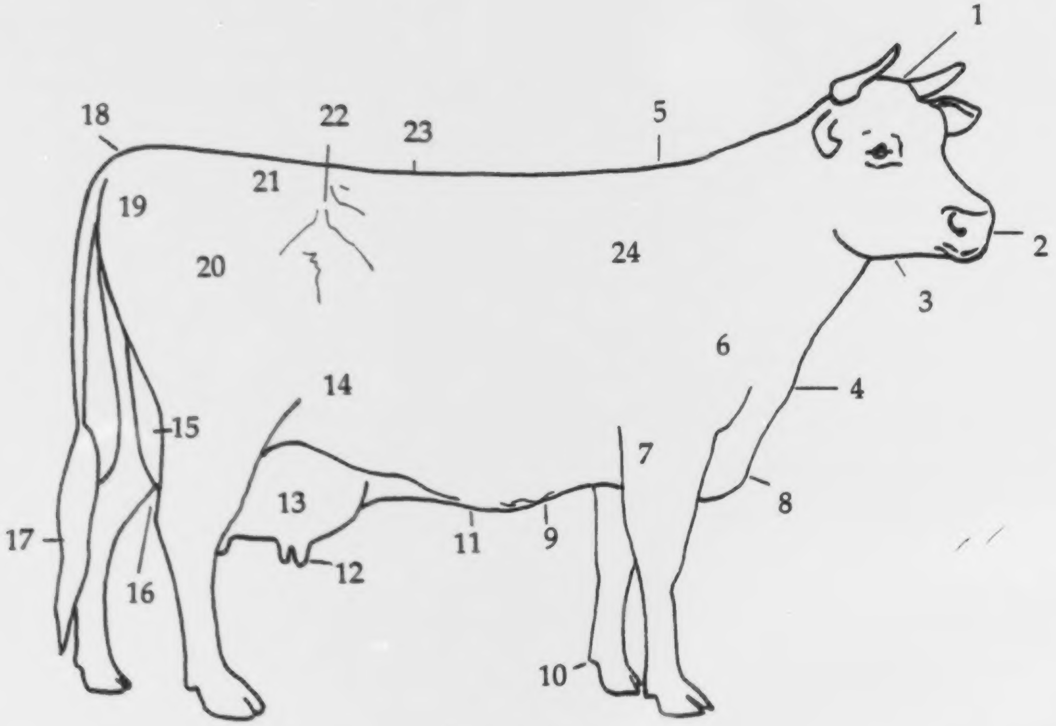
TRANSPARENCY MASTER #4

Parts of a Dairy Cow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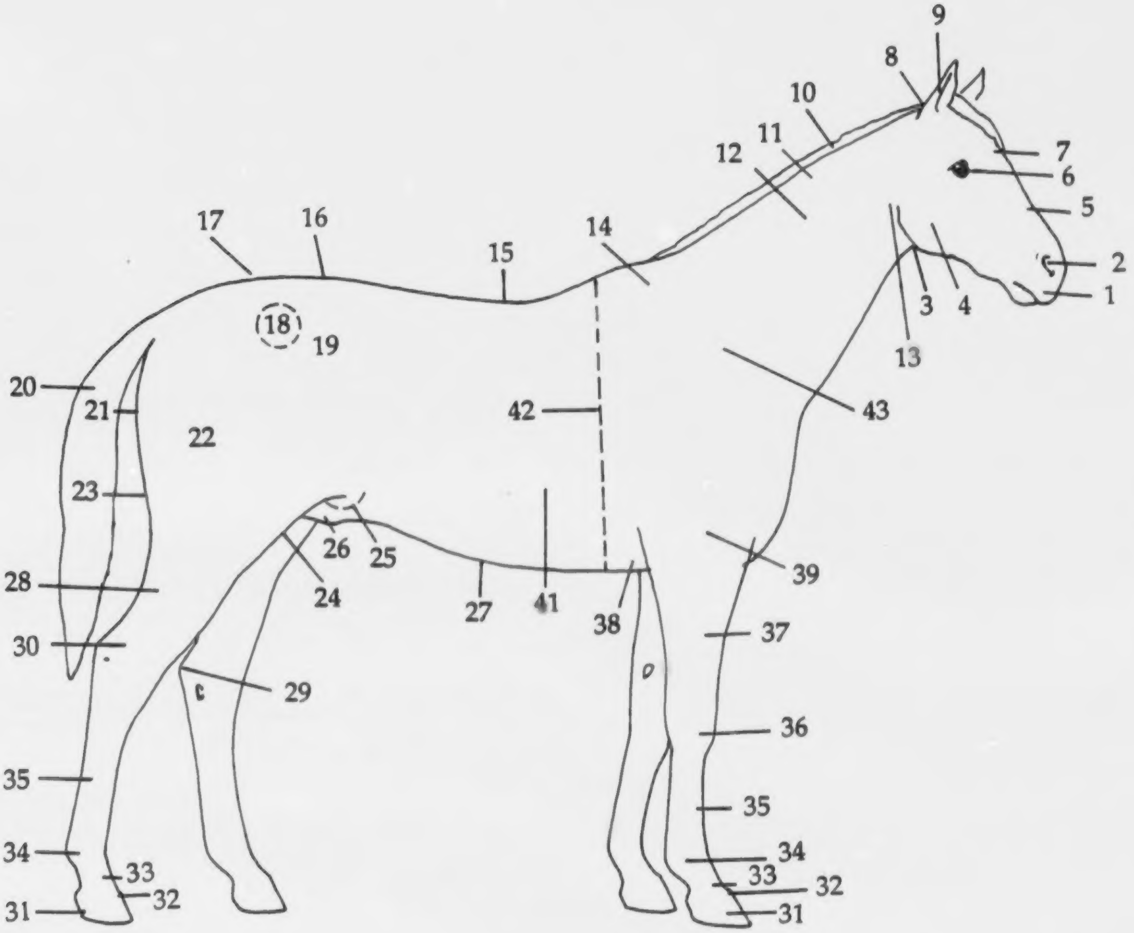
TRANSPARENCY MASTER #5

Parts of a Horse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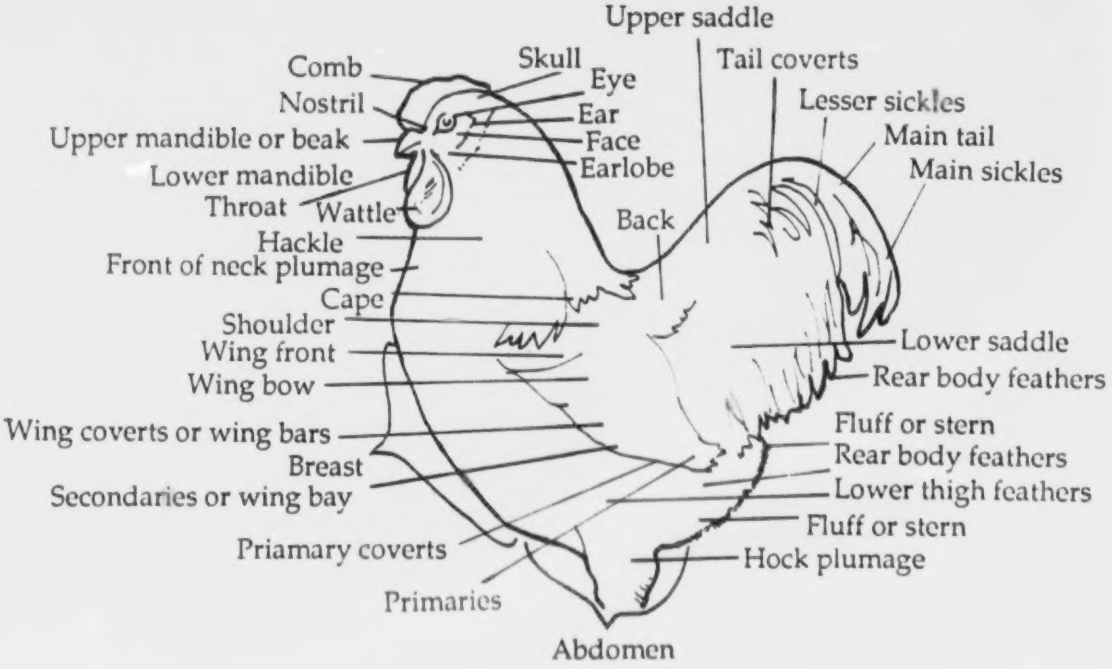
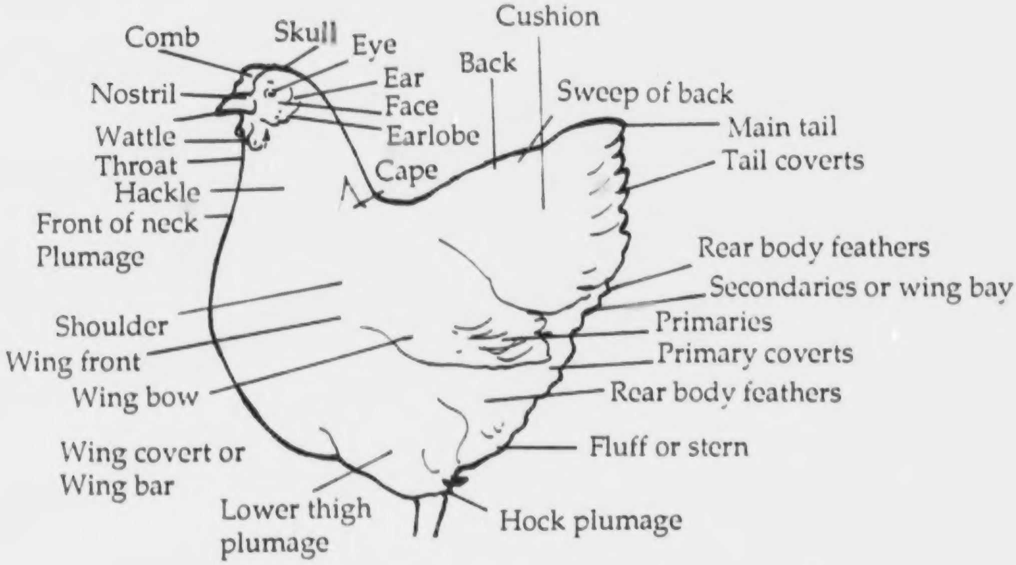
TRANSPARENCY MASTER #6

Parts of a Chicken


Upper saddle
Comb
Skull
Eye
Tail coverts
Lesser sickles
Nostril
Ear
Main tail
Upper mandible or beak
Face
Main sickles
Earlobe
Lower mandible
Throat
Wattle
Back
Hackle
Front of neck plumage
Cape
Shoulder
Wing front
Lower saddle
Wing bow
Rear body feathers
Fluff or stern
Wing coverts or wing bars
Rear body feathers
Breast
Lower thigh feathers
Secondaries or wing bay
Fluff or stern
Priamary coverts
Hock plumage
Primaries
Abdomen

Parts of the male chicken


Cushion
Comb
Skull
Eye
Back
Ear
Nostril
Face
Sweep of back
Earlobe
Main tail
Wattle
Throat
Cape
Tail coverts
Hackle
Front of neck
Plumage
Rear body feathers
Secondaries or wing bay
Shoulder
Primaries
Wing front
Primary coverts
Wing bow
Rear body feathers
Fluff or stern
Wing covert or
Wing bar
Lower thigh
plumage
Hock plumage

Parts of the female chicken

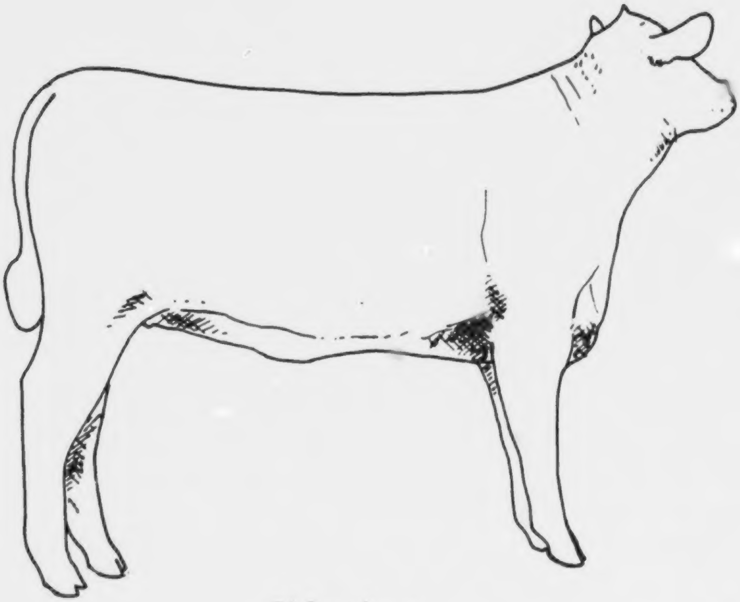
TRANSPARENCY MASTER #7

Criteria to Use in Selecting Breeding Stock

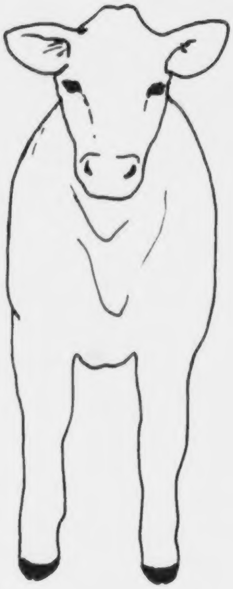
1. Growthiness
2. Soundness
3. Conformation
4. Condition at birth
5. Previous performance
6. Substance
7. Wool
8. Age
9. Sex character
10. Breed type

TRANSPARENCY MASTER #8

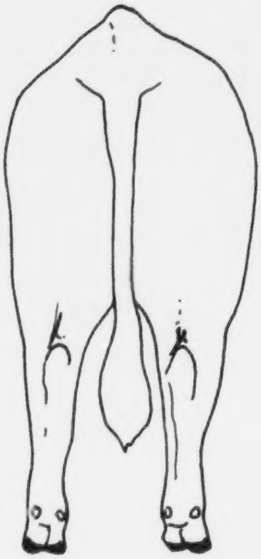
Ideal Beef Conformation



Side view



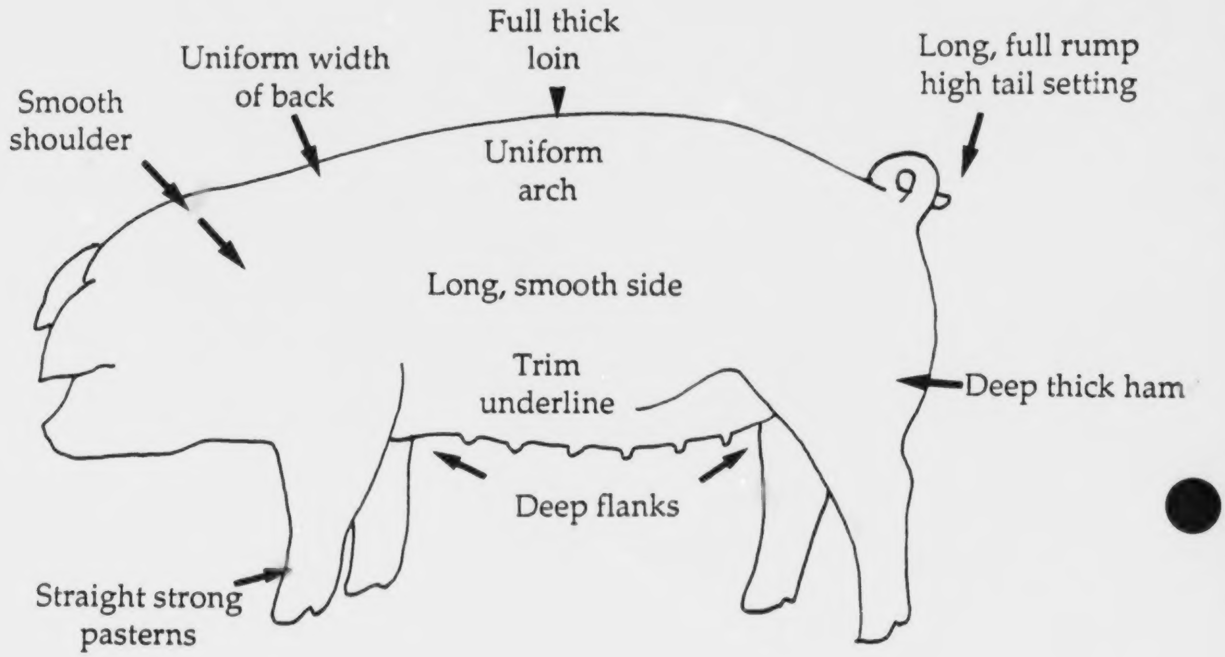
Front view



Rear view

TRANSPARENCY MASTER #9

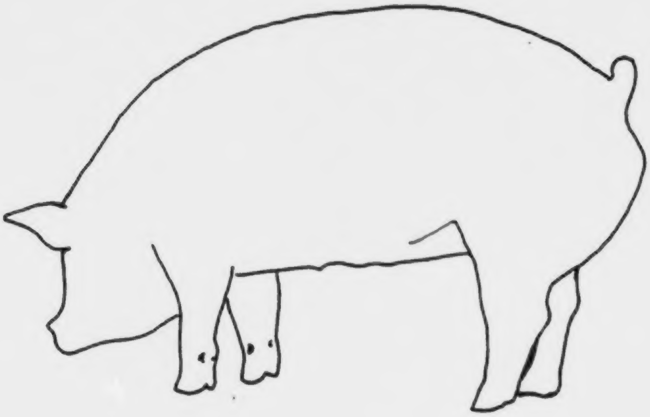
Major Parts of a Hog

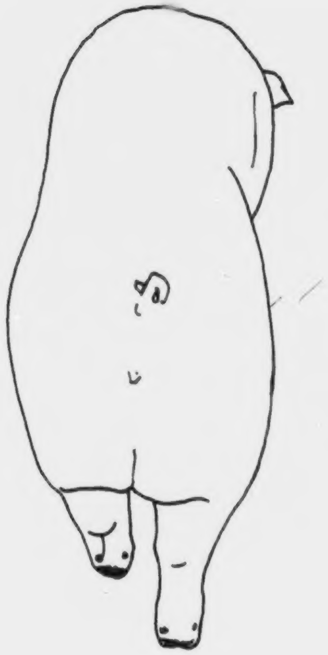

Full thick loin
Uniform width of back
Smooth shoulder
Long, full rump high tail setting
Uniform arch
Long, smooth side
Trim underline
Deep thick ham
Deep flanks
Straight strong pasterns

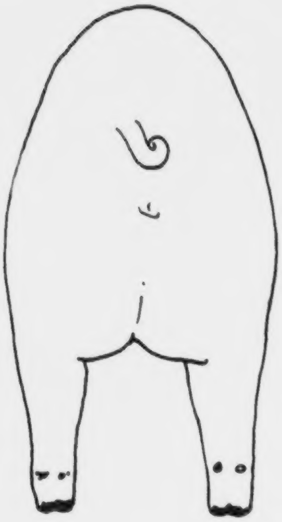
417

TRANSPARENCY MASTER #10

Modern Meat Type Hogs

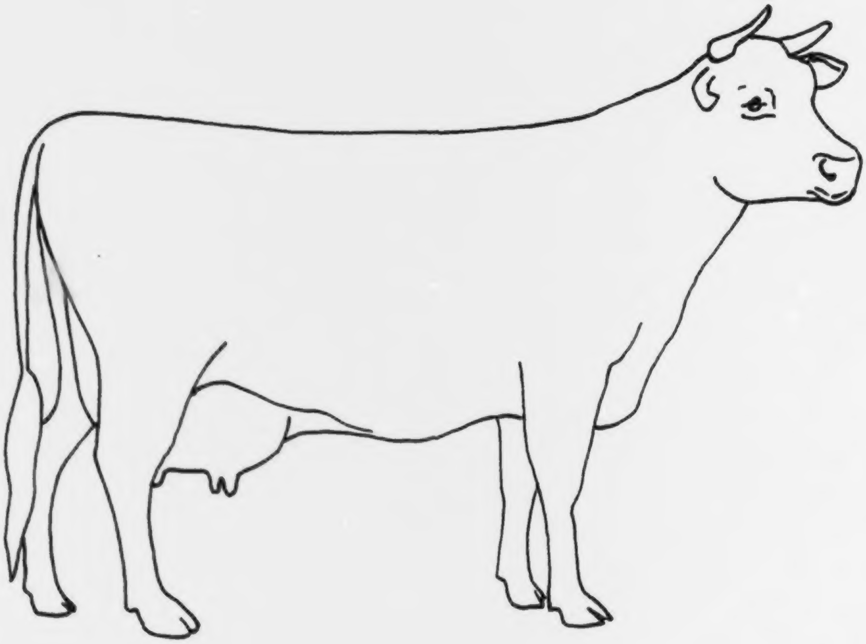






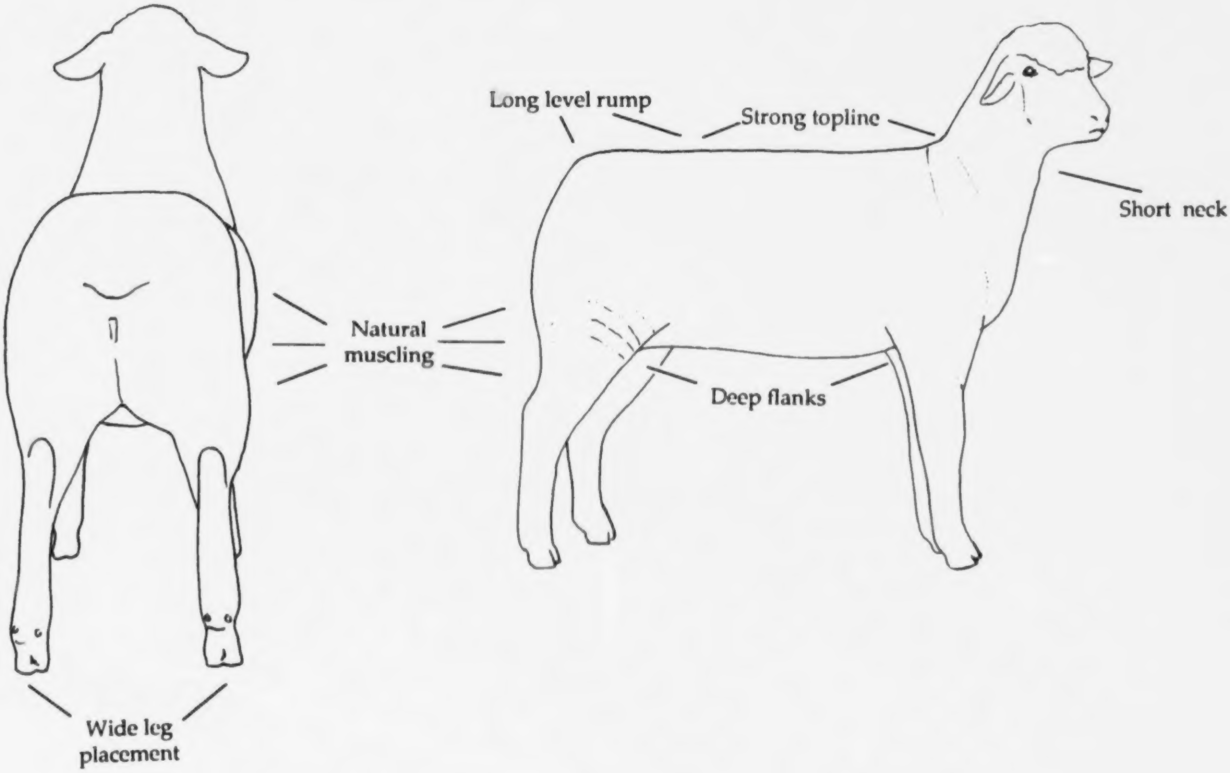
TRANSPARENCY MASTER #11

Good Conformation of a Dairy Cow



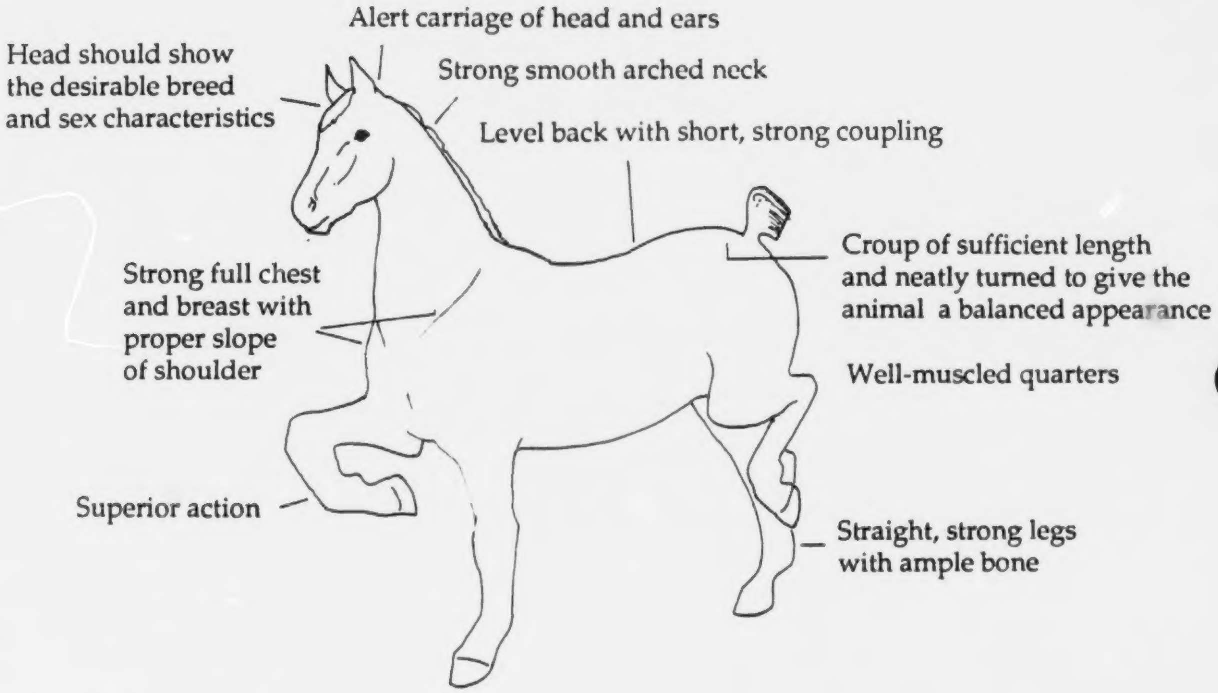
TRANSPARENCY MASTER #12

Good Conformation of a Sheep


Long level rump
Strong topline
Short neck
Natural muscling
Deep flanks
Wide leg placement

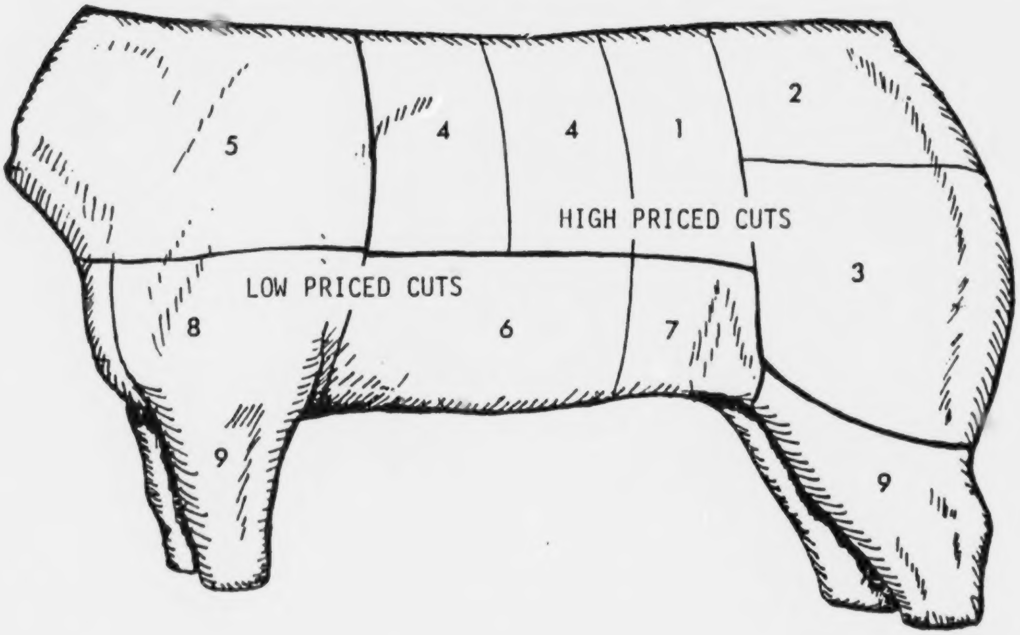
TRANSPARENCY MASTER #13

Some Desirable Conformation Features of the Horse


Alert carriage of head and ears
Head should show the desirable breed and sex characteristics
Strong smooth arched neck
Level back with short, strong coupling
Croup of sufficient length and neatly turned to give the animal a balanced appearance
Strong full chest and breast with proper slope of shoulder
Well-muscled quarters
Superior action
Straight, strong legs with ample bone

TRANSPARENCY MASTER #14

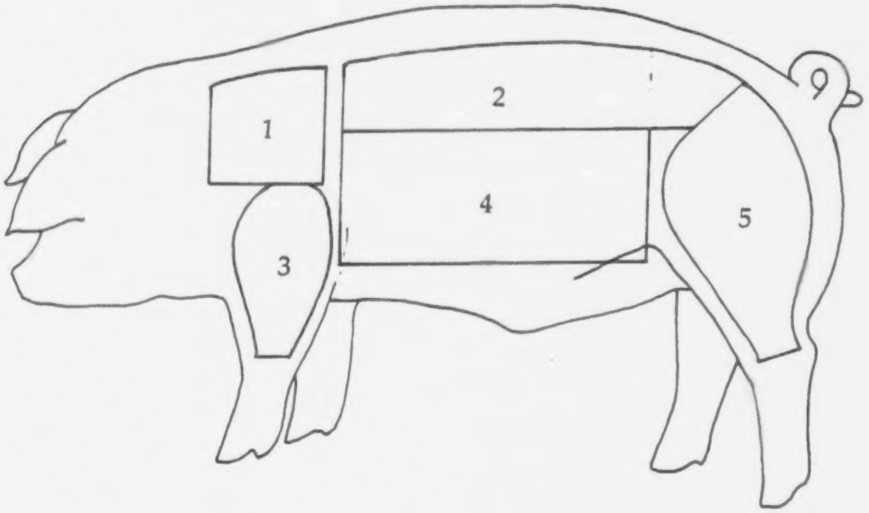
Wholesale Cuts of a Beef Carcass


5
4
4
1
2
HIGH PRICED CUTS
3
LOW PRICED CUTS
8
6
7
9
9

422

TRANSPARENCY MASTER #15

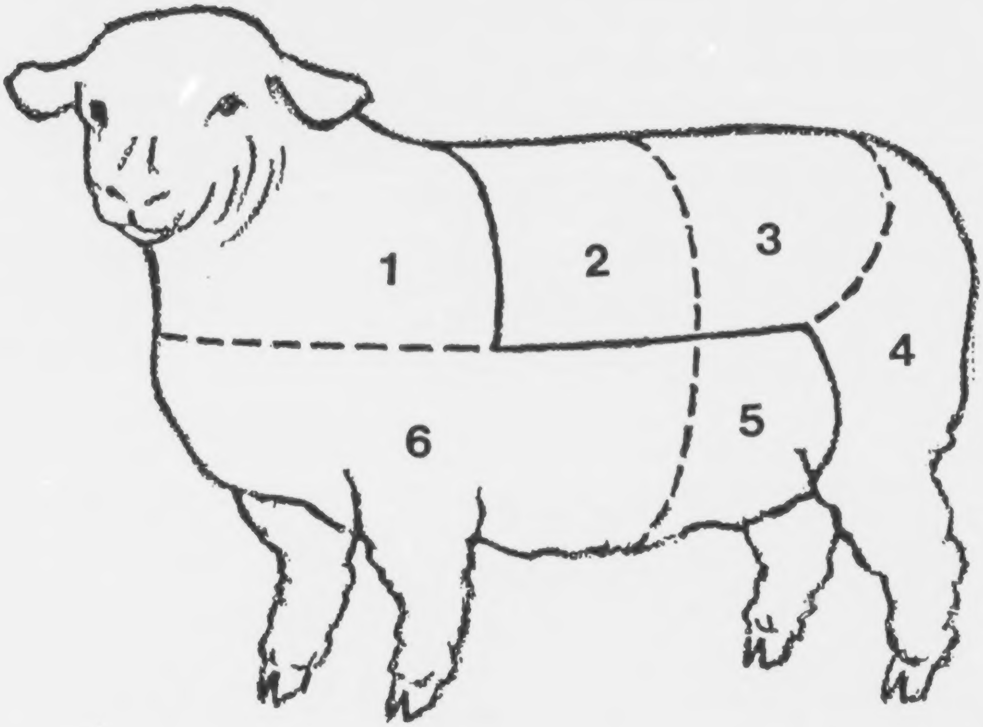
Wholesale Cuts of Pork



423

TRANSPARENCY MASTER #16

Wholesale Cuts of Lamb



STUDENT ACTIVITIES

STUDENT WORKSHEET #1 — Breeds of Beef Cattle

STUDENT WORKSHEET #2 — Breeds of Swine

STUDENT WORKSHEET #3 — Breeds of Sheep

STUDENT WORKSHEET #4 — Breeds of Dairy Cattle

STUDENT WORKSHEET #5 — Breeds of Poultry

STUDENT WORKSHEET #6 — Breeds of Horses

STUDENT WORKSHEET #7 — Identifying Parts of Live Animals

STUDENT WORKSHEET #8 — Selecting Beef Breeding Animals

STUDENT WORKSHEET #9 — Selecting Hogs

STUDENT WORKSHEET #10 — Selecting Breeding Sheep

STUDENT WORKSHEET #11 — Selecting Dairy Cattle

STUDENT WORKSHEET #12 — Selecting Horses

STUDENT WORKSHEET #13 — Identifying Wholesale Cuts of Animals

For additional activities, teachers may refer to the "Suggested Teaching Activities and Procedures" section in the Instructors Guide.

STUDENT WORKSHEET #1

Breeds of Beef Cattle

Breed	Origin (place & date)	Characteristics: A. Color C. Polled or horned B. Temperament D. Production	Advantages and disadvantages of breed

STUDENT WORKSHEET #1 (con't)

Breeds of Beef cattle

1. Match the following:

    a. ____ Hereford
    b. ____ Angus
    c. ____ Shorthorn
    d. ____ Charolais
    e. ____ Red Poll

    A. Red, white, or roan
    B. White
    C. Black
    D. Red
    E. Red with white face, feet and switch

2. Define a new breed ____________________

3. List 5 new breeds ____________________

4. Define an exotic breed ____________________

5. List 5 exotic breeds ____________________

6. Match the following:

    a. ____ Cow
    b. ____ Cull
    c. ____ Heifer
    d. ____ Stag
    e. ____ Calf
    f. ____ Steer

    A. Male animal used for breeding
    B. Male animal castrated after reaching sexual maturity
    C. Animal under 1 year of age
    D. Female animal that has had a calf
    E. Male animal castrated before reaching sexual maturity
    F. Female animal that has not had a calf

STUDENT WORKSHEET #2

Breeds of Swine

Breed	Origin (place & date)	Characteristics: A. Face B. Set of ears C. Color D. Size	Advantages and disadvantages of breed

STUDENT WORKSHEET #2 (con't)

Breeds of Swine

1. Match the following:

a. ______ Duroc
b. ______ Hampshire
c. ______ Spotted poland china
d. ______ Chester white
e. ______ Poland china
f. ______ Yorkshire
g. ______ Tamworth
h. ______ Berkshire
i. ______ Landrace

A. White, with erect ears, origin England
B. Black, with white belts, front legs and feet
C. White, with drooping ears, origin U.S.
D. Red, with drooping ears
E. Black and white, spotted
F. Red, with erect ears
G. White, with drooping ears, long-bodied animals
H. Black, with white feet, face and tail
I. Black, with occasional spots of white on legs, face

2. Circle the above breeds that originated in England.

3. Match the following:

a. ______ Cryptorchidism
b. ______ Hernia
c. ______ Hermaphrodite
d. ______ Blind teat
e. ______ Inverted nipple
f. ______ Pin nipple

A. A teat that gives no milk
B. When the testicles of the boar do not drop into the scrotum
C. A weakening of the muscles in the stomach which allows the internal organs to hang outside the animal
D. A nipple which is inside out
E. An animal that has characteristics of both male and female
F. A nipple that is so small there is danger of the pig injuring the nipple

4. Match the following:

a. ______ Boar
b. ______ Gilt
c. ______ Sow
d. ______ Barrow
e. ______ Stag
f. ______ Feeder pig
g. ______ Market hog

A. Male animal used for breeding
B. 30- to 60-pound pig
C. A pig that is being fed to go to market
D. A female that has had one litter of pigs
E. A female that has not had a litter of pigs
F. A male animal castrated before reaching sexual maturity
G. A male animal castrated after reaching sexual maturity

STUDENT WORKSHEET #3

Breeds of Sheep

Breed	Origin (place & date)	Characteristics: A. Wool B. Polled or horned C. Size D. Color E. Production	Advantages and disadvantages of breed

STUDENT WORKSHEET #3 (con't)

Breeds of Sheep

1. Match the following:

   a. ______ Corriedale
   b. ______ Columbia
   c. ______ Cheviot
   d. ______ Dorset
   e. ______ Hampshire
   f. ______ Rambouillet
   g. ______ Southdown
   h. ______ Suffolk

   A. Hornless, blackface, and long; muzzle moderately fine; ears medium to long and black

   B. Head strong and bold; ears carried well down on the side of the head; black or dark brown face and legs

   C. Head small, hornless, dark nose, topknot of wool and clean face are desirable, white face and legs

   D. Alert, compact in appearance; face slightly arched in ewes, nose black, white face and legs

   E. Medium-size ears, wide apart, with color to match face and legs; forelegs covered with wool down to the knees; head broad and short; hornless; face color of a uniform gray or mouse-brown, and well covered with wool

   F. Face free from wool around and under eyes; rams are horned and ewes are polled; nostrils large

   G. Both sexes hornless and open-faced; hair on face should be white; ears moderately long and free from wool; hooves either white or black

   H. Head is neat, face white, nostrils large; crown and jaws well covered with wool; both sexes horned; ears medium size; fleece extends well down on legs

2. Circle the above breeds that originated in England.

3. Name two breeds known for their high-quality wool.

   a. ____
   b. ____

4. What qualities or factors should you consider when selecting a breed of sheep for your SAE project?

5. Match the following terms:

   a. ______ Ewe
   b. ______ Fall lamb
   c. ______ Ram
   d. ______ Spring lamb
   e. ______ Wether

   A. Female sheep
   B. A mature male sheep
   C. A lamb born in fall and sold in spring
   D. A lamb born in spring and sold in fall
   E. Castrated male lamb under one year of age.

STUDENT WORKSHEET #4

Breeds of Dairy Cattle

Breed	Origin (place & date)	Characteristics: A. Color B. Polled or horned C. Size D. Temperament E. Production	Advantages and disadvantages of breed

STUDENT WORKSHEET #4 (con't)

Breeds of Dairy Cattle

1. Match the following:

a. ______ Holstein
b. ______ Ayrshire
c. ______ Guernsey
d. ______ Jersey
e. ______ Brown Swiss
f. ______ Milking Shorthorn

A. Light to deep cherry red, with white markings
B. Fawn varying from light to dark, may have black face and switch
C. Solid brown, light to dark
D. Red, red and white, white, or roan color
E. Black and white
F. A shade of fawn with white markings clearly defined

2. Define the following:

a. Bull ______________________________

b. Cow ______________________________

c. Heifer ______________________________

d. Stag ______________________________

e. 2% Milk ______________________________

f. Whole Milk ______________________________

3. Circle the two minor breeds and underline the two dual purpose dairy breeds.

Holstein
Red Danish
Dutch Belted
Red Poll

Devon
Jersey
Brown Swiss
Palomino

4. Why are dairy breeds so much larger than beef breeds? ______________________________

5. A cow normally has how many teats? ______________

6. Which dairy breed is usually the largest breed? ______________________

EXTRA CREDIT — What is colostrum? ______________________________

STUDENT WORKSHEET #5

Breeds of Poultry

Breed	Origin (place & date)	Characteristics: A. Comb type B. Color of shanks and toes C. Skin color D. Egg color E. Egg production F. Popularity of breed	Advantages and disadvantages of breed

STUDENT WORKSHEET #5 (con't)

Breeds of Poultry

1. Match the following:

   a. ________ Large White
   b. ________ Pekin
   c. ________ White Chinese
   d. ________ Rhode Island Red
   e. ________ Rouen
   f. ________ White Leghorn
   g. ________ Dark Cornish
   h. ________ Pilgrim
   i. ________ Medium White
   j. ________ Plymouth Rock

   A. 4 breeds of poultry
   B. 2 breeds of turkey
   C. 2 breeds of ducks
   D. 2 breeds of geese

2. What is the plumage color of the:

   a. White Leghorn? ________________________________
   b. Rhode Island Red? ________________________________

3. What is the egg color of the:

   a. White Leghorn? ________________________________
   b. Plymouth Rock? ________________________________

STUDENT WORKSHEET #6

Breeds of Horses

Breed	Origin (place & date)	Characteristics: A. Color B Temperament C. Pony, light horse, draft, or mule D. Use E. Size	Advantages and disadvantages of breed

STUDENT WORKSHEET #7

Identifying Parts of Live Animals

This worksheet is to be used with Transparency Masters #1 - #5.

A Beef Animal

1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________
6. ____________________
7. ____________________
8. ____________________
9. ____________________
10. ____________________
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17. ____________________
18. ____________________
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20. ____________________
21. ____________________
22. ____________________
23. ____________________
24. ____________________
25. ____________________
26. ____________________
27. ____________________
28. ____________________
29. ____________________
30. ____________________
31. ____________________

A Hog

1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________
6. ____________________
7. ____________________
8. ____________________
9. ____________________
10. ____________________
11. ____________________
12. ____________________
13. ____________________
14. ____________________
15. ____________________
16. ____________________

A Sheep

1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________
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15. ____________________
16. ____________________
17. ____________________
18. ____________________
19. ____________________
20. ____________________
21. ____________________
22. ____________________
23. ____________________
24. ____________________
25. ____________________
26. ____________________
27. ____________________

A Dairy Cow

1. ______________
2. ______________
3. ______________
4. ______________
5. ______________
6. ______________
7. ______________
8. ______________
9. ______________
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17. ______________
18. ______________
19. ______________
20. ______________
21. ______________
22. ______________
23. ______________
24. ______________

A Horse

1. ______________
2. ______________
3. ______________
4. ______________
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32. ______________
33. ______________
34. ______________
35. ______________
36. ______________
37. ______________
38. ______________
39. ______________
40. ______________
41. ______________
42. ______________
43. ______________

STUDENT WORKSHEET #7 — Key

Identifying Parts of Live Animals

This worksheet is to be used with Transparency Masters #1 - #5.

A Beef Animal

1. *Shank*
2. *Knee*
3. *Brisket*
4. *Dewlap*
5. *Jaw*
6. *Mouth*
7. *Nostril*
8. *Muzzle*
9. *Eye*
10. *Ear*
11. *Face*
12. *Poll*
13. *Neck*
14. *Shoulder*
15. *Crops*
16. *Back*
17. *Loin*
18. *Hook*
19. *Tail Head*
20. *Rump*
21. *Rear Flank*
22. *Round*
23. *Tail*
24. *Hock*
25. *Switch*
26. *Pastern*
27. *Fore Flank*
28. *Elbow*
29. *Arm*
30. *Dew Claw*
31. *Hoof*

A Hog

1. *Back*
2. *Loin*
3. *Rump*
4. *Ham*
5. *Hock*
6. *Pastern*
7. *Rear Flank*
8. *Belly*
9. *Underline*
10. *Fore Flank*
11. *Dew Claw*
12. *Shoulder*
13. *Neck*
14. *Jowl*
15. *Nose or snout*
16. *Ear*

A Sheep

1. *Mouth*
2. *Nostril*
3. *Face*
4. *Fore Head*
5. *Eye*
6. *Ear*
7. *Neck*
8. *Breast*
9. *Top of shoulder*
10. *Crops*
11. *Back*
12. *Loin*
13. *Hip*
14. *Rump*
15. *Dock*
16. *Thigh or leg*
17. *Hock*
18. *Hind Leg*
19. *Dew Claw*
20. *Foot*
21. *Hind Flank*
22. *Stifle*
23. *Belly or paunch*
24. *Ribs*
25. *Fore Flank*
26. *Fore Leg*
27. *Shoulder*

A Dairy Cow

1. *Poll*
2. *Nostril*
3. *Jaw*
4. *Dewlap*
5. *Withers*
6. *Shoulder Point*
7. *Elbow*
8. *Brisket*
9. *Milk Well*
10. *Dew Claw*
11. *Mild Vein*
12. *Teats*
13. *Fore Udder*
14. *Flank*
15. *Rear Udder*
16. *Hock*
17. *Switch*
18. *Tail Head*
19. *Pins*
20. *Thurls*
21. *Rump*
22. *Hook Bones*
23. *Loin*
24. *Crops*

A Horse

1. *Muzzle*
2. *Nostril*
3. *Jaw*
4. *Cheek*
5. *Face*
6. *Eye*
7. *Forehead*
8. *Poll*
9. *Ear*
10. *Mane*
11. *Crest*
12. *Neck*
13. *Throatlatch*
14. *Wither*
15. *Back*
16. *Loin*
17. *Croup*
18. *Hip*
19. *Coupling*
20. *Tail*
21. *Point of buttocks*
22. *Thigh*
23. *Quarter*
24. *Stifle*
25. *Rear Flank*
26. *Sheath*
27. *Underline*
28. *Gaskin*
29. *Point of Hock*
30. *Hock*
31. *Foot*
32. *Coronet*
33. *Pastern*
34. *Fetlock*
35. *Cannon*
36. *Knee*
37. *Forearm*
38. *Point of Elbow*
39. *Arm*
40. *Point of Shoulder*
41. *Ribs*
42. *Heart girth*
43. *Shoulder*

STUDENT WORKSHEET #8

Selecting Beef Breeding Animals

1. List the two factors that selection of beef breeding animals should be based upon.

   a. ______________________________

   b. ______________________________

2. Define type of individuality of a beef breeding animal. ______________________________

   ____

   ____

3. What is meant by "desirable breed characteristics"? ______________________________

   ____

   ____

4. What factors are considered under "desirable physical characteristics"? (side, rear, front) ______________

   ____

   ____

5. What can be determined by handling the animal? ______________________________

   ____

   ____

6. What factors should be considered when "selecting on production"? ______________________________

   ____

   ____

STUDENT WORKSHEET #9

Selecting Hogs

1. Why is quality being stressed more today when buying and selling market hogs? ______

2. Why is meat-type hog more desirable than the short, chuffy animals and the rangy animals? ______

3. The selection of breeding by "type" involves looking at various parts of the animal. Briefly discuss each heading giving the desirable type.

   a. General appearance — ______

   b. Conformation — ______

   c. Quality — ______

   d. Condition — ______

   e. Feet and legs — ______

4. Discuss the major points to consider when selecting feeder pigs. ______

STUDENT WORKSHEET #10

Selecting Breeding Sheep

1. How is "type" evaluated? ______________________________

2. How is "producing ability" evaluated? ______________________________

3. Discuss the characteristics to consider when viewing the lamb from the side. ______________________________

4. Discuss the characteristics to consider when viewing the lamb from the rear and front. ______________________________

5. Discuss the factors to consider when handling the lamb. ______________________________

6. What factors are considered when buying groups of lambs? ______________________________

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STUDENT WORKSHEET #11

Selecting Dairy Cattle

1. When selecting dairy cattle on "type," what should you know? ____________________

____

____

2. List the desirable physical characteristics that should be considered when viewing the dairy cow from the side.

____

____

3. List the desirable physical characteristics that should be considered when viewing the dairy cow from the front and rear.

____

____

4. What factors should be considered at close range? ____________________

____

____

5. What information can be useful when selecting dairy cows with their "production records"? __________

____

____

6. What information is obtained on a good "production pedigree" record? ____________________

____

____

STUDENT WORKSHEET 12

Selecting Horses

1. List 4 points to consider when deciding what kind of horse to buy.

   a. ______________________________

   b. ______________________________

   c. ______________________________

   d. ______________________________

2. What are desirable characteristics that should be considered when viewing a horse from the side? __________

   ____

   ____

3. Describe the differences in proper and faulty conformation of front and rear legs. __________

   ____

   ____

4. What is meant by "good action"? ______________________________

   ____

   ____

5. What is meant by "soundness"? ______________________________

   ____

   ____

6. List five points of unsoundness that are commonly found in a horse and describe how these points contribute to unsoundness. ______________________________

   ____

   ____

STUDENT WORKSHEET #13

Identifying Wholesale Cuts of Animals

This worksheet is to be used with Transparency Masters #14 - #16.

A. Identify the wholesale cuts of the beef animal and give the approximate percentage of yield of each wholesale cut.

	Name of Cut	Percentage Yield
1.	____________	____________
2.	____________	____________
3.	____________	____________
4.	____________	____________
5.	____________	____________
6.	____________	____________
7.	____________	____________
8.	____________	____________
9.	____________	____________

B. Identify the wholesale cuts of pork and give the approximate percentage of yield of each wholesale cut.

1.	____________	____________
2.	____________	____________
3.	____________	____________
4.	____________	____________
5.	____________	____________

C. Identify the wholesale cuts of lamb and give the approximate percentage of yield of each wholesale cut.

1.	____________	____________
2.	____________	____________
3.	____________	____________
4.	____________	____________
5.	____________	____________
6.	____________	____________

44C

STUDENT WORKSHEET #13 — Key

Identifying Wholesale Cuts of Animals

This worksheet is to be used with Transparency Masters #14 - #16.

A. Identify the wholesale cuts of the beef animal and give the approximate percentage of yield of each wholesale cut.

	Name of Cut	Percentage Yield
1.	*loin*	*19%*
2.	*rump*	*4%*
3.	*round*	*20%*
4.	*rib*	*9%*
5.	*chuck*	*25%*
6.	*plate*	*7%*
7.	*flank*	*5%*
8.	*brisket*	*4%*
9.	*shank*	*3%.*

B. Identify the wholesale cuts of pork and give the approximate percentage of yield of each wholesale cut.

1.	*shoulder*	*10%*
2.	*loin*	*20%*
3.	*picnic*	*13%*
4.	*bacon*	*17%*
5.	*ham*	*22-28%*

C. Identify the wholesale cuts of lamb and give the approximate percentage of yield of each wholesale cut.

1.	*shoulder*	*32%*
2.	*rack*	*7%*
3.	*loin*	*8%*
4.	*leg*	*33%*
5.	*flank*	*5%*
6.	*breast*	*15%*

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Understanding Animal Anatomy and Physiology

RELATED PROBLEM AREAS:

1. Understanding Basic Genetics and Reproduction (Central Core Cluster)
2. Classifying Animals
3. Meeting Nutritional Needs of Animals
4. Animal Breeding and Reproduction
5. Maintaining Animal Health
6. Meeting the Environmental Requirements of Animals
7. Caring for Animals
8. Recognizing the Impact of Technology on Agriculture: Biotechnology (Central Core Cluster)

PREREQUISITE PROBLEM AREA(S)

1. Identifying Basic Principles of Animal Science (Central Core Cluster)

LEVEL: Orientation

OCCUPATIONAL TASKS ADDRESSED:

Agricultural Business and Management Cluster

Duty A: Formulating Livestock Feeding Programs

1. Assess livestock needs such as growing and fattening, nursing, production, or special nutritional needs

Duty N: Breeding, Handling, and Caring for Animals

1. Inseminate animals artificially
2. Pregnancy test animals
3. Assist animals in delivery
4. Assist young to nurse
5. Castrate animals
6. Dehorn animals
7. Restrain animals

Duty O: Maintaining Animal Health

1. Inspect animals for disease
2. Administer medication
3. Treat wounds

Duty Q: Loading, Securing, Transporting, and Unloading Agricultural Products

1. Load livestock
2. Unload livestock

STATE GOALS FOR LEARNING:

In planning the instruction for this problem area, teachers can promote the development of several student learning objectives which are related to the State Goals for Learning in Biological and Physical Sciences. These objectives are listed on the Learning Assessment Plan forms included on the following page(s). Those learning objectives marked with an asterisk (*) are taken from the sample lists provided by the Illinois State Board of Education.

CORE

Illinois Agricultural Core Curriculum

Agricultural Education 124 Mumford Hall 1301 W. Gregory Drive University of Illinois Urbana, IL 61801

Director: Dale A. Law, Ed.D.
Principal Investigator: Jerry D. Pepple, Ed.D.
Research Assistant: Robert E. Petrea

Submission Date ____________

☐ Original submission ☐ Revision

Page ____ of ____

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)

COUNTY	DISTRICT	ESC

District Name

City

I. LEARNING AREA *(check one)*

☐ Language Arts
☐ Mathematics
☒ Sciences
☐ Fine Arts
☐ Social Sciences
☐ Physical Development/Health

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will have a working knowledge of the concepts and basic vocabulary of biological, physical, and environmental sciences and their application to life and work in contemporary technological society.

Contact Person: ____________
Title: ____________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Understand that complex animals carry out vital processes within organ systems which are separate in function but mutually dependent.					
*2. Identify and describe functions of tissues and organs. *3. Identify body changes and explain how hormones cause some of these body changes.					
4. Define the basic terms integral to animal anatomy and physiology. 5. Identify major organs of the body and describe their functions.					
6. Identify the basic systems of the body. 7. Name the major organs associated with each of the basic systems of the body.					
8. Recognize the interdependence of the basic systems on one another to maintain life.					
9. Summarize functional interdependence of the basic systems of the body.					
10. Recognize the effects of the basic systems on an organism's ability to live and grow.					
*11. Recognize basic animal systems using preserved specimens.					451

Understanding Animal Anatomy and Physiology

Agricultural Business and Managment
Animal Science

Submission Date ____________
☐ **Original submission** ☐ **Revision**
Page _____ of _____

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

(Affix label or complete district information.)

COUNTY	DISTRICT	ESC

District Name

City

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☒ Sciences ☐ Physical Development/Health

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will have a working knowledge of the principles of scientific research and their application in simple research projects.

Contact Person: ____________
Title: ____________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Demonstrate the ability to draw conclusions from collected data.					

ISBE 41-78 (1/88)

Understanding Animal Anatomy and Physiology

Illinois Agricultural Core Curriculum Rev.

Agricultural Business and Managment
Animal Science

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Understanding Animal Anatomy and Physiology

STUDENT LEARNING OBJECTIVES

Upon completion of their study of this problem area, students will be able to:

1. Define basic terms integral to animal anatomy and physiology.
2. Identify major organs of the body and describe their function.
3. Identify the basic systems of the body.
4. Name the major organs associated with each of the basic systems of the body.
5. Recognize the interdependence of the basic systems on one another to maintain life.
6. Summarize the functional interdependence of the basic systems of the body.
7. Recognize the effects of the basic systems on the organism's ability to live and grow.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Understanding Animal Anatomy and Physiology

PROBLEMS AND QUESTIONS FOR STUDY **INSTRUCTOR'S NOTES AND REFERENCES**

1. What are organs?
2. Why are organs important to an organism?
3. What are the organs found in animals?
4. How do the various organs function?
5. What is a system?
6. What are the systems found in animals?
7. What organs make up the various systems?
8. Why are systems useful to animals?
9. How are systems connected?
10. Why are systems interconnected?
11. What is the means of communication among the various systems of the body?
12. What systems provide a stimulus that causes other systems to react?
13. How do the various systems react when a stimulus is provided?
14. How does an animal respond to the products of the basic system?

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Understanding Animal Anatomy and Physiology

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES

1. Use other life science personnel as resource persons for supplies, equipment and ideas.
2. Use this problem area as a unit of instruction prior to preparation for judging contests for enhanced student understanding.
3. Plan field trips to a slaughter facility, an animal diagnostic lab, a veterinary office, and any facility at which students may observe the internal anatomical features of animals.
4. Secure prepared specimens of models to show comparative features of specific species.
5. Secure copies of Instructional Materials Service #8392, *Anatomy and Physiology of Animals,* for use as student reference and student study guide.
6. Plan field trips to production facilities to observe anatomical variations among animals of the same species and to discuss with producers the economic consequences of such variations.
7. Use student SAEs or class projects as sources of discussion to show differences in anatomy and physiology and effects of those differences.
8. Use Student Worksheet #1 as an example of ruminant uniqueness and as an example of a symbiotic relationship. Lead students in a discussion of the pros and cons of feeding corn to ruminants for production of meat and milk as opposed to feeding this same corn to starving people.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Understanding Animal Anatomy and Physiology

REFERENCES

*1. *Anatomy and Physiology of Farm Animals.* (1974). Frandson, R.D. Lea and Febiger, West Washington Square, Philadelphia, PA 19105.

2. *College Zoology.* (1981). Boolootian, R.A., Stiles, K.A. MacMillan Publishing Company, 866 Third Avenue, New York, NY 10022.

*3. *Integrated Principles of Zoology.* (1988). Hickman, C.D., Jr., Roberts, L.S., Hickman, F.M. Time Mirror/Mosby College Publishing, 11830 Westline Industrial Drive, St. Louis, MO 63146.

4. *Animal Anatomy and Physiology.* (Subject Matter Unit #8392). Instructional Materials Service, Texas A & M University, P.O. Box 2588, College Station, TX 77843-2588.

5. *Introduction to Animal Biology.* (1979). Villee, C.A., Walker, Jr., W.F., Barnes, R.D. W.B. Sanders Company, West Washington Square, Philadelphia, PA 19105.

6. *Dukes' Physiology of Domestic Animals.* (1983). Swenson, Melvin J. (ed.). Cornell University Press, 124 Roberts Place, Ithaca, NY 14850.

*7. *The Science Workbook of Student Research Projects in Food-Agriculture and Natural Resources.* (1985). College of Agriculture, The Ohio State University, 2120 Fyffe Road, Columbus, OH 43210. (614) 422-1734.

*Indicates highly recommended reference

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTIONAL RESOURCES

These resources are intended for use by teachers in planning and teaching the materials for this problem area and may be adapted to fit the teaching method(s) used.

INFORMATION SHEET #1 — Terms to be Defined

INFORMATION SHEET #2 — Introduction to Anatomy and Physiology

INFORMATION SHEET #3 — Animal Behavior

TRANSPARENCY MASTER #1 — Anatomical Systems and Structures

TRANSPARENCY MASTER #2 — Cross Section of Skin (with discussion guide)

TRANSPARENCY MASTER #3 — The Parts of a Bone (with discussion guide)

TRANSPARENCY MASTER #4 — Skeletal Structures of Domestic Animals (with discussion guide)

TRANSPARENCY MASTER #5 — Circulation Through the Heart (with discussion guide)

TRANSPARENCY MASTER #6 — Circulatory Systems (with discussion guide)

TRANSPARENCY MASTER #7 — Digestive Systems of Domestic Animals (with discussion guide)

TRANSPARENCY MASTER #8 — Respiratory Systems of Domestic Animals (with discussion guide)

TRANSPARENCY MASTER #9 — Respiratory Surfaces of the Lung (with discussion guide)

TRANSPARENCY MASTER #10 — Muscular Structures of Domestic Animals (with discussion guide)

TRANSPARENCY MASTER #11 — Excretory System and Shapes of Kidneys (with discussion guide)

TRANSPARENCY MASTER #12 — Nervous System of Domestic Animals and Anatomy of the Brain (with discussion guide)

TRANSPARENCY MASTER #13 — Endocrine System (with discussion guide)

TRANSPARENCY MASTER #14 — Sagittal Section of Udder of Cow (with discussion guide)

INFORMATION SHEET #1

Terms to be Defined

Abductor — a muscle that draws a structure away from a point of reference, such as the midventral line of the body.

Adductor — a muscle that draws a structure toward a point of median axis, usually the midventral line of the body; or a muscle closing a shell.

Afferent — leading toward a center; designating vessels or neurons that transmit blood or impulses toward a point of reference; neurons that transmit impulses toward the central nervous system.

Alveolus — a small saclike cavity; the terminal chamber of air passages in the mammalian lung.

Androgen — testosterone or one of the other vertebrate male sex hormones.

Archenteron — the main cavity of the gastrula, lined with endoderm, which represents the rudiment of the digestive system.

Auricle — the external ear flap of mammals.

Capillaries — microscopic thin-walled vessels connecting arteries and veins, and traversing walls of which substances pass to the interstitial fluid.

Cecum — a blind pouch into which open the ileum and the colon.

Cephalization — concentration of nervous tissue and sense organs at the anterior end of the body (the head).

Cerebellum — the part of the vertebrate brain which controls muscular coordination.

Cerebrum — a major portion of the vertebrate brain, occupying the upper part of the cranium; forming the largest part of the central nervous system in humans.

Coenzyme — a substance which is required for some particular enzymatic reaction to occur.

Convergent evolution — the independent evolution of similar structures, which carry on similar functions, in two or more organisms of widely different, unrelated ancestry.

Cutaneous — pertaining to the skin.

Defecation — the elimination of excrement, much of which is undigested food that has not been metabolised.

Diencephalon — a major substance division of the brain lying between the telencephalon and mesencephalon; includes the epithalamus, thalamus and hypothalamus.

Differentiation — a process of changing a relatively unspecialized cell to a more specialized cell.

Efferent — denoting certain vessels or neurons that transmit blood or impulses away from a point of reference; neurons that conduct impulses away from the central nervous system.

Endocrine — applied to ductless glands whose function is to secrete into the blood or lymph a substance that has a specific effect on another organ or part.

Epithelium — the layer of tissue covering the lining of cavities and vessels and external surfaces of the body.

Estrogen — one of the female sex hormones, produced by the ovarian follicle, which promotes the development of the secondary sex characteristics.

Eustachian tube — the auditory tube passing between the middle ear cavity and pharynx of most terrestrial vertebrates.

Excretion — removal of metabolic wastes by an organism.

Extensor — a muscle that serves to extend or straighten a limb.

Facilitation — the promotion or hastening of any natural process; the reverse of inhibition.

Filtration — the passage of a liquid through a filter following a pressure gradient.

Gastrodermis — the tissue lining the gut cavity that is responsible for digestion and absorption.

Glycolysis — the enzymatic breakdown of sugars into simpler compounds.

Habitat — the natural living area of an animal or plant species; the physical area in which it may be found.

Heterotrophs — organisms which cannot synthesize their own food from inorganic materials (photosynthesis) and therefore must live either at the expense of autotrophs or upon decaying matter.

Homozygous — possessing an identical pair of alleles at the corresponding loci of chromosomes for a given character.

Hormones — substances produced in cells in one part of the body which are transported by the blood stream to cells in other parts of the body where they regulate and coordinate their activities.

Hypothalamus — a region of the forebrain, which contains various centers controlling autonomic activities: visceral activities, water balance, temperature, sleep, and so on.

Ileum — the terminal portion of the small intestine of higher vertebrates lying just anterior to the colon.

Implantation — the attachment of the developing embryo to the epithelial lining (endometrium) of the uterus.

Inflammation — mobilization of body defenses against foreign agents: pain, increased temperature, redness, and accumulation of leukocytes.

Integument — skin, the covering or enveloping layer.

Interstitial fluid — the liquid that is found between the cells and tissues of the body.

Kinesthesis — sense which gives us our awareness of the position and movement of the various parts of the body.

Latent period — an interval between the application of a stimulus and the beginning of the visible shortening of a muscle.

Lipase — an enzyme that accelerates the synthesis of fats.

Lymph — the colorless fluid which is derived from blood plasma and resembles it closely in composition; contains white cells.

Matrix — nonliving material secreted by and surrounding the connective tissue cells; frequently contains a thick, interlacing matted network of microscopic fibers.

Mesentery — one of the membranes in vertebrates that extend from the body wall to the visceral organs or from one organ to another.

Metabolism — the transformations by which energy and matter are made available for the uses of the organism.

Metamerism — the division of the body into a linear series of similar parts or segments, as in annelids and chordates.

Metencephalon — a major subdivision of the brain lying between the mesencephalon and myelencephalon; includes the cerebellum and pons.

Motor unit — all the skeletal muscle fibers that are stimulated by a single motor neuron.

Nutrient — a general term for any substance which can be used in the metabolic processes of the body.

Olfaction — the act of smelling.

Parallel evolution — the independent evolution of similar structures in two or more closely related organisms, e.g., the independent evolution of quills from hair by American and African porcupines.

Parasympathetic — one of the subdivisions of the autonomic nervous system; fibers originate in the anterior and posterior spinal cord and innervate primarily the internal organs.

Parathyroids — small glands situated in the thyroid gland; their secretion is concerned chiefly with regulating the metabolism of calcium and phosphorous by the body.

Pepsin — a proteolytic enzyme secreted by the cells lining the stomach.

Pericardium — the lining of that part of the coelom that forms a separate chamber containing the heart.

Pharynx — in higher vertebrates it is bounded anteriorly by the mouth and nasal cavities and posteriorly by the esophagus and larynx.

Pheromone — a substance secreted by one organism into the environment which influences the development or behavior of other members of the same species.

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Pituitary — a small gland which lies just below the hypothalamus of the brain, to which it is attached by a narrow stalk

Placenta — a vascular structure formed in part from tissues derived from the embryo and in part from maternal tissues — the lining of the uterus — by means of which the embryo and fetus receive nutrients and oxygen and eliminate waste.

Polymorphism — occurrence of several distinct phenotypes in a population.

Portal system — a group of veins beginning and ending in a capillary bed in another organ rather than directly to the heart, e.g., the renal portal system and hepatic portal system.

Predation — relationship in which one species adversely affects the second but cannot live without it; the first species kills and devours the second.

Progesterone — the hormone produced in the corpus luteum of the ovary and in the placenta; regulates estrous and menstrual cycles and maintains pregnancy.

Prosimian — a member of the more primitive of two arboreal primate suborders; an ancestral primate or a contemporary lemur, loris, tarsier, or one of their allies.

Protease — an enzyme that catalyzes the digestion of proteins.

Proteins — macromolecules containing carbon, hydrogen, oxygen, nitrogen, and usually sulfur and phosphorus; composed of chains of amino acids joined in peptide bonds; present in all cells.

Race — a division of a species; a population which differs from other populations with respect to the frequency of one or more genes.

Reduction — the addition of electrons to an atom or molecule; opposite of oxidation.

Regeneration — regrowth of a lost or injured tissue or part of an organism.

Releasing hormones — short peptides synthesized in the hypothalamus, secreted into the hypothalamo-hypophyseal portal system and carried to the pituitary, where they initiate the synthesis and release of specific pituitary hormones.

Reptile — a member of a class of terrestrial vertebrates which are covered with horny scales or plates; living representatives include turtles, lizards, snakes, and crocodiles.

Respiration — process by which animal and plant cells utilize oxygen, produce carbon dioxide, and conserve the energy of foodstuff molecules in biologically useful forms such as ATP; the act or function of breathing.

Retroperitoneal — organs located behind the peritoneum that may bulge into the coelom but are still covered by the coelomic lining, or peritoneum.

Saturation deficit — the difference between the amount of water vapor a given volume of air could contain at a specific temperature and the amount it actually contains.

Secretion — the production and release by a cell of some substance that is used elsewhere in the body in some process.

Solute — molecules dissolved in a solvent, producing a solution.

Solvent — the fluid medium in which the solute molecules are dissolved in a true solution.

Sphincter — a group of circularly arranged muscle fibers whose contractions close a tubular opening by constriction.

Standard metabolism — the amount of energy expended by an animal at rest.

Steroids — complex molecules which contain the male and female sex hormones and the adrenal cortical hormones.

Sympathetic system — a division of the autonomic nervous system in which fibers leave the central nervous system with certain thoracic and lumbar nerves and go to the sweat glands and visceral organs; has an effect on most organs that is antagonistic to parasympathetic stimulation.

Synapse — the junction of neuron processes through which impulses pass between the axon of one neuron and the dendrite of the next.

Systole — the contraction of the heart; the interval between the first and second heart sounds during which blood is forced into the aorta and pulmonary arteries.

Telencephalon — the most anterior of the five major subdivisions of the brain; includes the olfactory bulbs and cerebral hemispheres.

Tetrapod — four-footed vertebrates, or ones with a secondary reduction in limb number that evolved from quadrupeds; amphibians, reptiles, birds, and mammals.

Tissue — group of similarly specialized cells which together perform certain special functions; e.g., muscle tissue, bone tissue, nerve tissue.

Trachea — an air-conducting tube; in terrestrial vertebrates, the main trunk of the system of tubes through which air passes to and from the lungs.

Umbilical cord — the stalk, or cord, attached to the navel and connecting the embryo with the placenta

Ureter — the tube which conveys urine from a kidney to the cloaca or exterior of the body.

Vein — a vessel through which the blood passes from the tissues towards the heart; typically has thin walls and contains valves that prevent a reverse flow of blood.

Ventricle — a cavity in an organ such as one of the several cavities of the brain or one of the chambers of the heart that receive blood from the atria.

Villus — a small, fingerlike vascular process or protrusion, especially a protrusion from the wall of the small intestine.

Visceral — pertaining to the internal organs in the body cavity.

Viviparous — bearing living young which develop from eggs within the body of the female, deriving nutrition from the maternal organism through a special organ, the placenta, which is a union of certain fetal membranes and the uterine lining.

Zygote — the cell formed by the union of two gametes; a fertilized egg.

Adapted from *Introduction to Animal Biology* and *Integrated Principles of Zoology.*

INFORMATION SHEET #2

Introduction to Anatomy and Physiology

While there is enormous diversity among animals in general there are basic similarities to be found. When one looks beyond individual cells and cells grouped into tissues, the next organizational unit found is the organ. An organ is a group of tissues organized into a unit to perform a particular function. An organ may consist of most or all the basic tissue types, and organs in general have a characteristic plan in that one of the tissues is dominant in performing that particular organ's function. Organs are in turn formed into systems that perform one of the 11 basic functions characteristic of higher animals. These basic functions, such as procurement of nutrients, movement, and reproduction are basic and necessary whether the subject is a fish or a horse.

Thus one arrives at the disciplines of Anatomy and Physiology. Anatomy is the study of the structures within an organism and the arrangement of those structures. Structures observed may be gross and able to be seen with the unaided eye, such as organs and systems; or micro, needing to be viewed through a microscope, such as certain tissues. Physiology is the study of the function of structures, whether individual organs or systems.

It should be pointed out that the distinction of systems is a convenient means to understand the interrelationships that exist among anatomical structures. The interrelationship between tissue and cell is that the cells must work properly for the tissue which is constructed from them to function. Similarly, the various tissues of an organ must work cooperatively for the organ to function and provide the usefulness for the system of which it is a part. If one follows the workings of a single cell it is evident that without the circulatory system nutrients would not be available. The muscular system, through the heart and arterial muscles, provides the impulse necessary to move nutrients. The nervous system provides impulses to contract the muscle fibers. Energy is only available to be expended by the cells because of the digestive system. The respiratory system provides the oxygen needed for metabolism and removes the carbon dioxide produced. The excretory system removes waste products. All the systems come under the protection of the integumentary system The skeletal system provides moveability and support and also produces red blood cells. The endocrine system not only secretes hormones for growth and development but also monitors and controls most metabolic activity.

The fact that these tissues, organs, and systems are common to and necessary for most species of animals does not limit the variety of arrangements of these structures in the various species. The arrangement of the structures for a particular species is dependent on the needs of that species.

INFORMATION SHEET #3

Animal Behavior

It may seem, at first, that the subject of animal behavior is misplaced under the heading of anatomy and physiology. While categorically this may be true, the study of the arrangement and function of anatomical structures is not complete without a view of the expression of that arrangement and function. The interconnection, intercommunication, and interdependence of organs and systems that are necessary to maintain life are ultimately responses to changes that occur in the environment. The activities of an animal, which are manifestations of responses, constitute its behavior.

Behavior is not static. A newborn behaves different than an adult. This change reflects not only development of the individual but also change in the environment. Some behaviors are irregularly performed; others occur at cyclic intervals.

The following is a list of terms associated with behavior:

1. Aggression — complex response, usually hostile; may be external or internal.
2. Conditioning — pairs a novel stimulus with an established one; eventually the novel stimulus alone may elicit the established response (e.g., milk letdown in response to the sound of the vacuum pump).
3. Courting — mutual tactile activity, specialized postures, specialized calls, and mate choice.
4. Imprinting — an instinctive behavior by which the first large object experienced by a newborn becomes the memory trace for the "parent."
5. Instinct — a complex behavior that is inherited and invoked by a particular stimulus and leads to a particular result.
6. Kineses — undirected locomotion responses.
7. Learning — a change in behavior gained through experience.
8. Memory — storage of a prior image.
9. Migration — response to environment; usually results in a move to a more favorable environment for feeding or breeding.
10. Reflex — a relatively simple automatic response that is independent of higher nerve centers; more important to lower animals.
11. Response — reaction to a stimulus; may be internal or external.
12. Social behavior — activities associated with hierarchies, territorial rights, and leadership.
13. Stimulus — a change that brings a response; may be internal or external.
14. Taxis — complicated, directed response toward or away from stimuli.

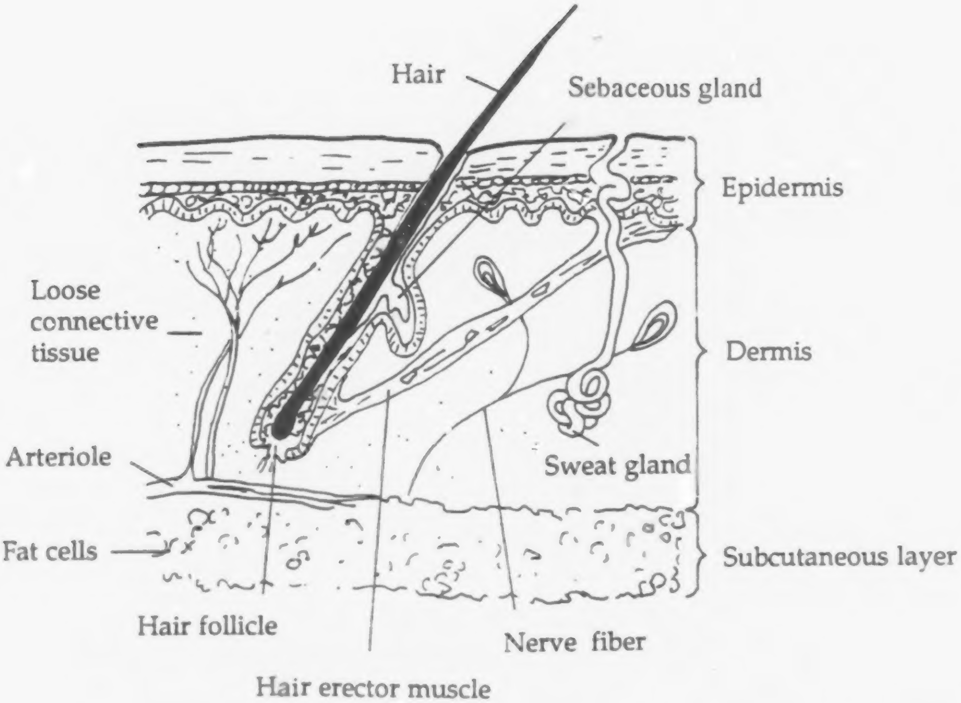
TRANSPARENCY MASTER #1

Anatomical Systems and Structures

System	Chief Structures
Skeletal system	Bones, joints
Muscular system	Muscles
Digestive system	Stomach and intestines
Respiratory system	Lungs and air passages
Urinary system	Kidneys and bladder
Reproductive system	Ovaries and testes
Endocrine system	Ductless glands
Nervous system	Brain, spinal cord, nerves
Circulatory system	Heart, vessels
Integumentary system	Skin
Sensory system	Eye, ear

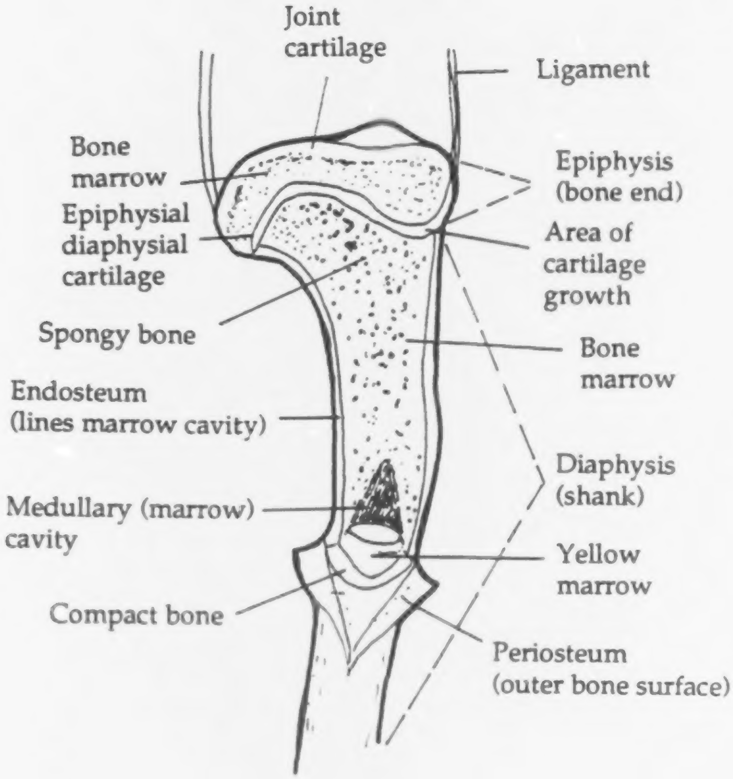
TRANSPARENCY MASTER #2

Cross Section of Skin


Hair
Sebaceous gland
Epidermis
Loose connective tissue
Dermis
Arteriole
Sweat gland
Fat cells
Subcutaneous layer
Hair follicle
Nerve fiber
Hair erector muscle

TRANSPARENCY MASTER #3

The Parts of a Bone


Joint cartilage
Ligament
Bone marrow
Epiphysis (bone end)
Epiphysial diaphysial cartilage
Area of cartilage growth
Spongy bone
Bone marrow
Endosteum (lines marrow cavity)
Diaphysis (shank)
Medullary (marrow) cavity
Yellow marrow
Compact bone
Periosteum (outer bone surface)

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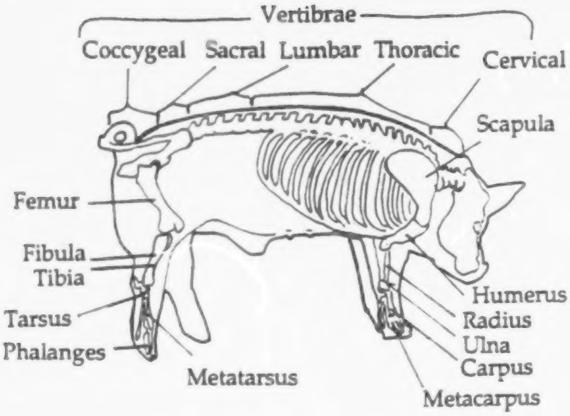
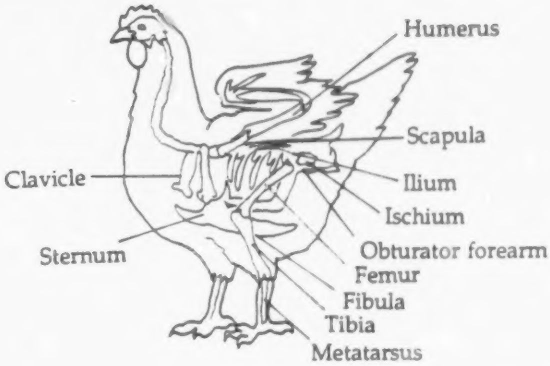
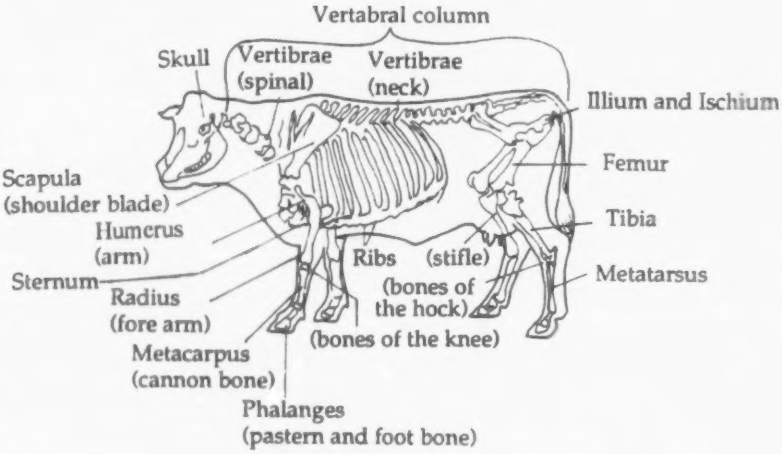
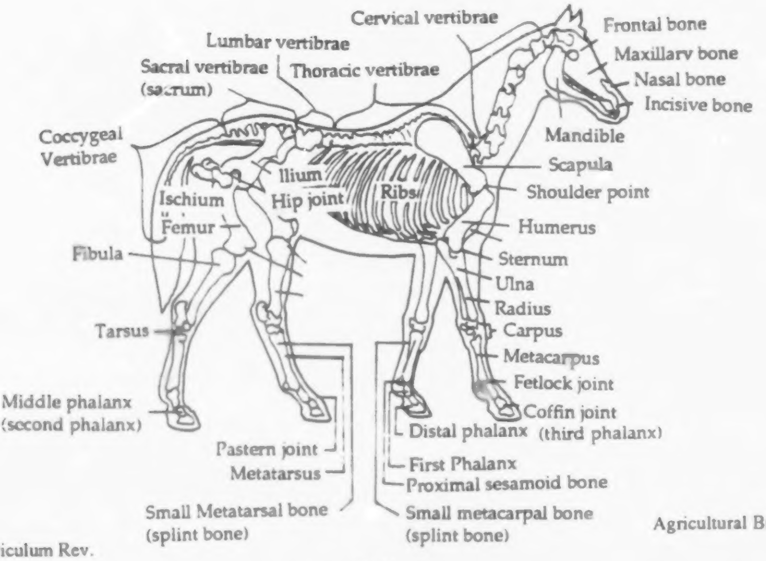
TRANSPARENCY MASTER #4

Skeletal Structures of Domestic Animals


Vertibrae
Coccygeal
Sacral
Lumbar
Thoracic
Cervical
Scapula
Femur
Fibula
Tibia
Tarsus
Phalanges
Metatarsus
Humerus
Radius
Ulna
Carpus
Metacarpus

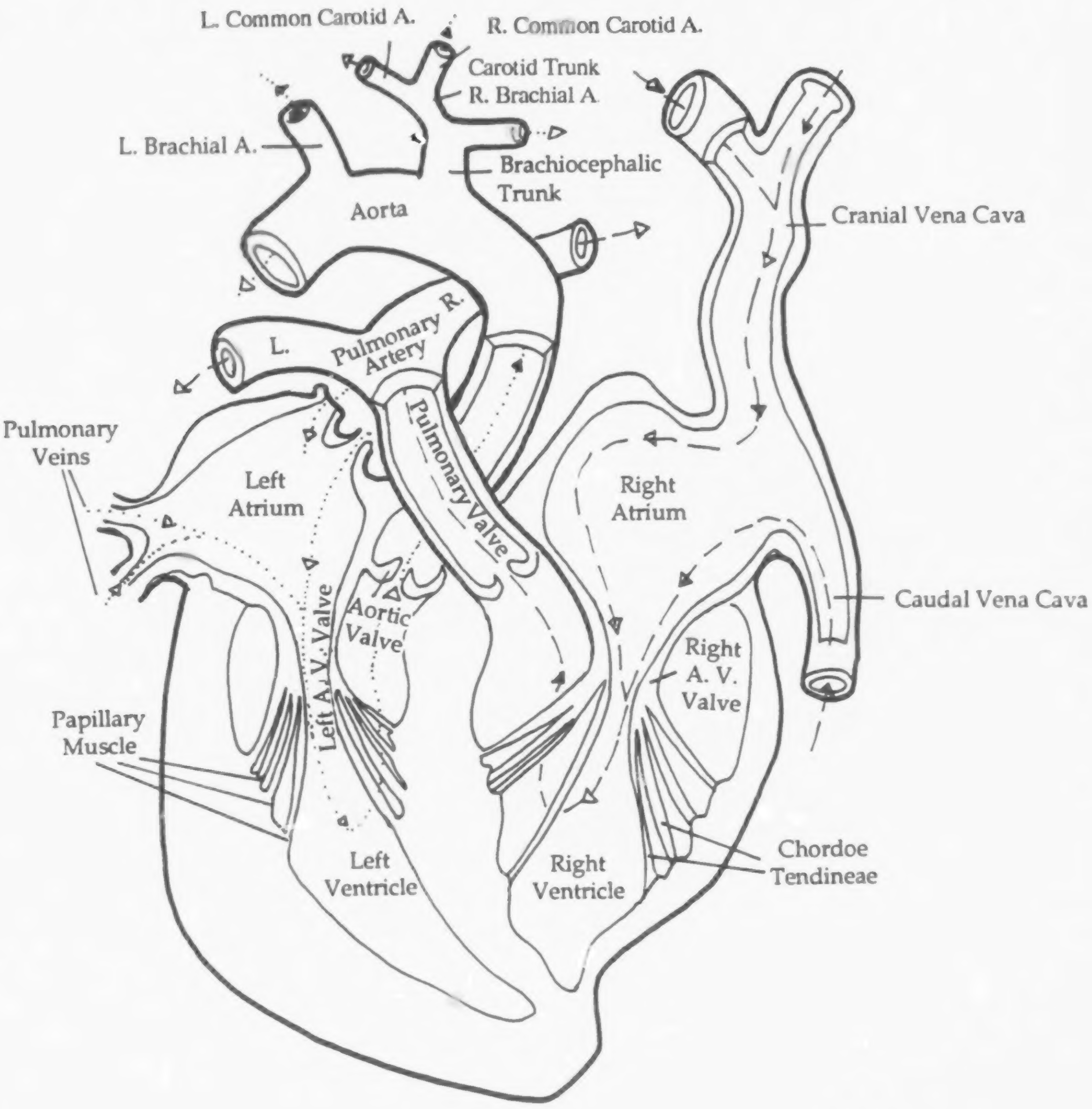

Humerus
Scapula
Clavicle
Ilium
Ischium
Sternum
Obturator forearm
Femur
Fibula
Tibia
Metatarsus


Vertabral column
Skull
Vertibrae (spinal)
Vertibrae (neck)
Illium and Ischium
Femur
Scapula (shoulder blade)
Tibia
Humerus (arm)
Ribs
(stifle)
Metatarsus
Sternum
Radius (fore arm)
(bones of the hock)
(bones of the knee)
Metacarpus (cannon bone)
Phalanges (pastern and foot bone)


Cervical vertibrae
Frontal bone
Lumbar vertibrae
Maxillarv bone
Sacral vertibrae (sacrum)
Thoracic vertibrae
Nasal bone
Incisive bone
Coccygeal Vertibrae
Mandible
Scapula
Ilium
Ischium
Hip joint
Ribs
Shoulder point
Femur
Humerus
Fibula
Sternum
Ulna
Radius
Tarsus
Carpus
Metacarpus
Fetlock joint
Middle phalanx (second phalanx)
Coffin joint (third phalanx)
Distal phalanx
Pastern joint
Metatarsus
First Phalanx
Proximal sesamoid bone
Small Metatarsal bone (splint bone)
Small metacarpal bone (splint bone)

TRANSPARENCY MASTER #5

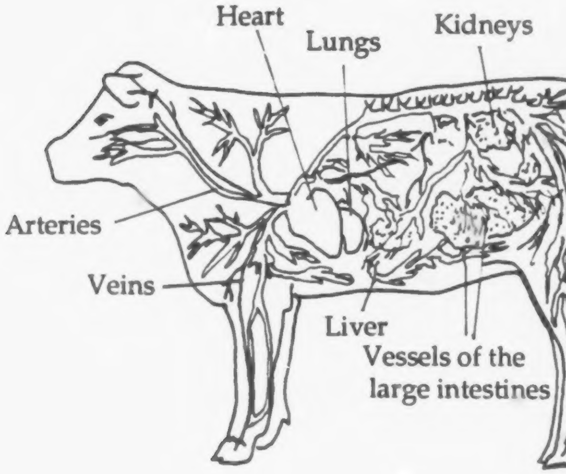
Circulation Through the Heart

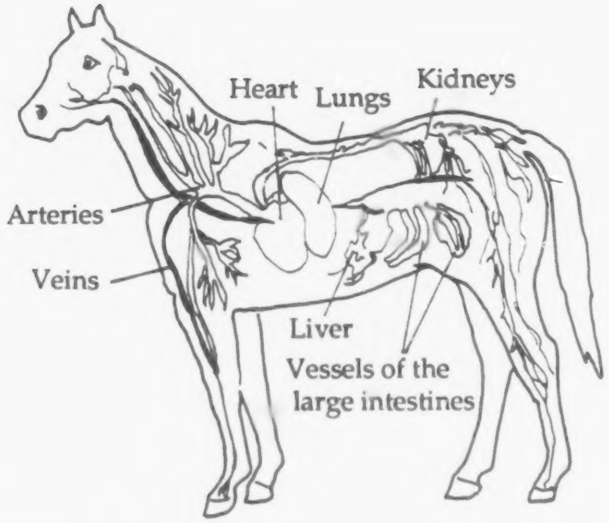

L. Common Carotid A.
R. Common Carotid A.
Carotid Trunk
R. Brachial A.
L. Brachial A.
Brachiocephalic Trunk
Aorta
Cranial Vena Cava
L.
Pulmonary Artery
R.
Pulmonary Veins
Left Atrium
Pulmonary Valve
Right Atrium
Aortic Valve
Left A. V. Valve
Caudal Vena Cava
Right A. V. Valve
Papillary Muscle
Left Ventricle
Right Ventricle
Chordoe Tendineae

Structure of the heart. Arrows indicate direction of blood flow. Dotted lines represent oxygenated (arterial) blood. Broken lines represent unoxygenated (venous) blood.

TRANSPARENCY MASTER #6

Circulatory Systems


Heart
Lungs
Kidneys
Arteries
Veins
Liver
Vessels of the large intestines


Heart
Lungs
Kidneys
Arteries
Veins
Liver
Vessels of the large intestines

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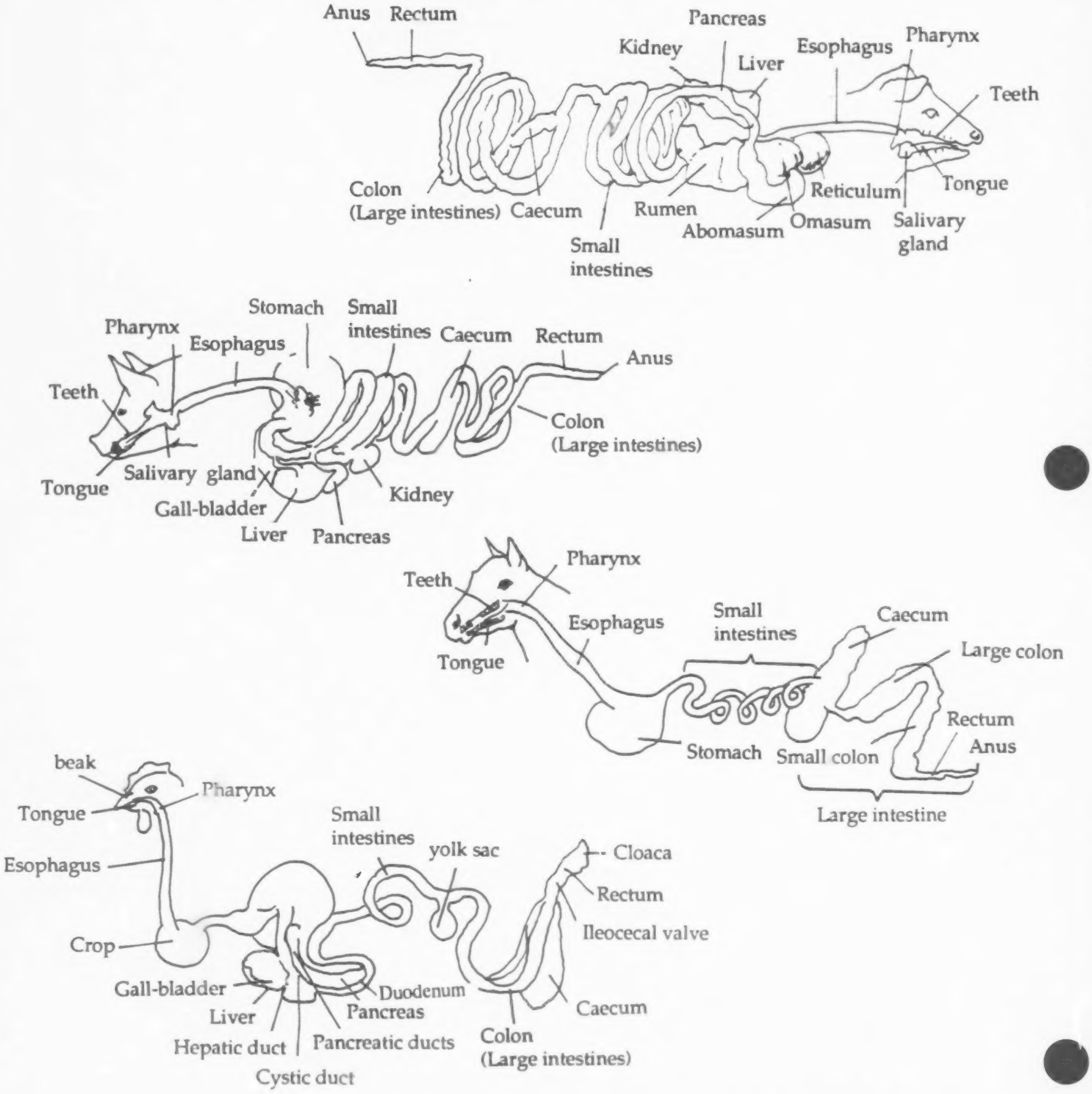
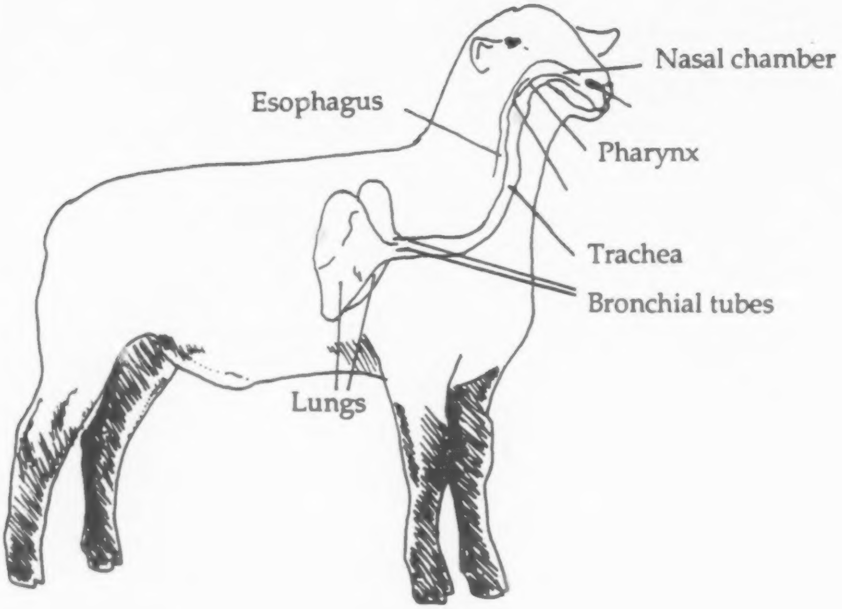
TRANSPARENCY MASTER #7

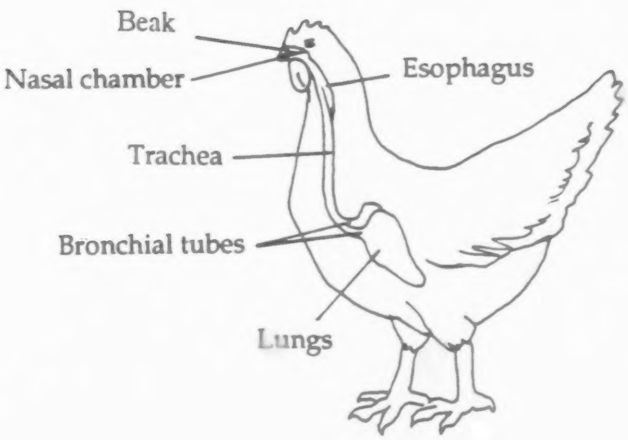
Digestive Systems of Domestic Animals


Anus
Rectum
Pancreas
Kidney
Liver
Esophagus
Pharynx
Teeth
Tongue
Colon (Large intestines)
Caecum
Small intestines
Rumen
Abomasum
Omasum
Reticulum
Salivary gland
Stomach
Pharynx
Esophagus
Small intestines
Caecum
Rectum
Anus
Teeth
Colon (Large intestines)
Tongue
Salivary gland
Gall-bladder
Liver
Pancreas
Kidney
Teeth
Pharynx
Esophagus
Tongue
Small intestines
Caecum
Large colon
Rectum
Anus
Stomach
Small colon
Large intestine
beak
Pharynx
Tongue
Esophagus
Crop
Small intestines
yolk sac
Cloaca
Rectum
Ileocecal valve
Gall-bladder
Liver
Duodenum
Pancreas
Caecum
Hepatic duct
Pancreatic ducts
Colon (Large intestines)
Cystic duct

TRANSPARENCY MASTER #8

Respiratory Systems of Domestic Animals


Nasal chamber
Esophagus
Pharynx
Trachea
Bronchial tubes
Lungs


Beak
Nasal chamber
Esophagus
Trachea
Bronchial tubes
Lungs

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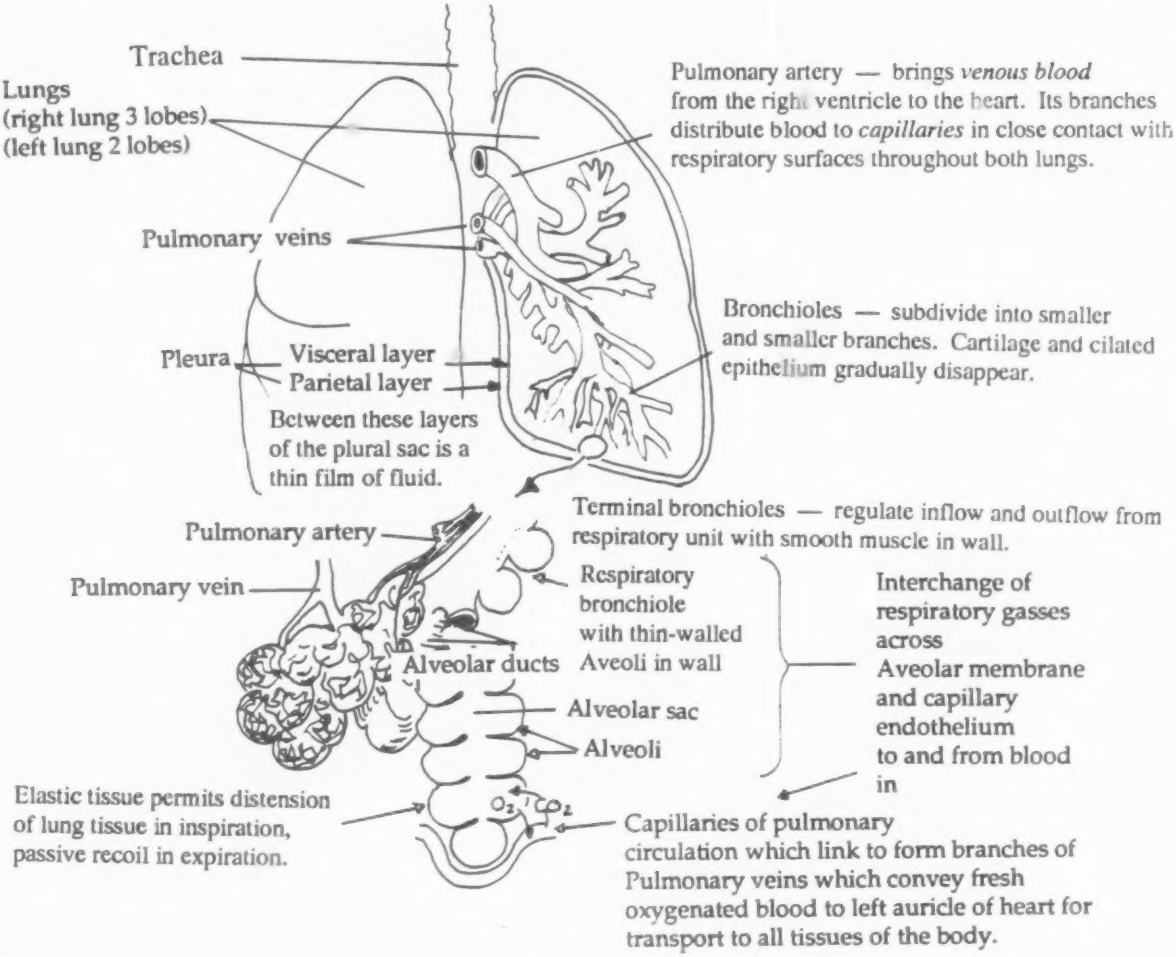
TRANSPARENCY MASTER #9

Respiratory Surfaces of the Lung

The trachea and the Bronchial "tree" conduct air to the respiratory surfaces. There is no exchange of gases in these tubes.


Trachea
Lungs
(right lung 3 lobes)
(left lung 2 lobes)
Pulmonary veins
Pleura
Visceral layer
Parietal layer
Pulmonary artery
Pulmonary vein
Alveolar ducts
Respiratory bronchiole with thin-walled Aveoli in wall
Alveolar sac
Alveoli
O_2 CO_2

Pulmonary artery — brings *venous blood* from the right ventricle to the heart. Its branches distribute blood to *capillaries* in close contact with respiratory surfaces throughout both lungs.

Bronchioles — subdivide into smaller and smaller branches. Cartilage and cilated epithelium gradually disappear.

Between these layers of the plural sac is a thin film of fluid.

Terminal bronchioles — regulate inflow and outflow from respiratory unit with smooth muscle in wall.

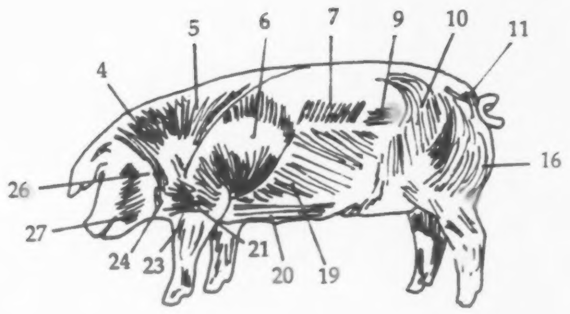
Interchange of respiratory gasses across Aveolar membrane and capillary endothelium to and from blood in

Elastic tissue permits distension of lung tissue in inspiration, passive recoil in expiration.

Capillaries of pulmonary circulation which link to form branches of Pulmonary veins which convey fresh oxygenated blood to left auricle of heart for transport to all tissues of the body.

TRANSPARENCY MASTER #10

Muscular Structures of Domestic Animals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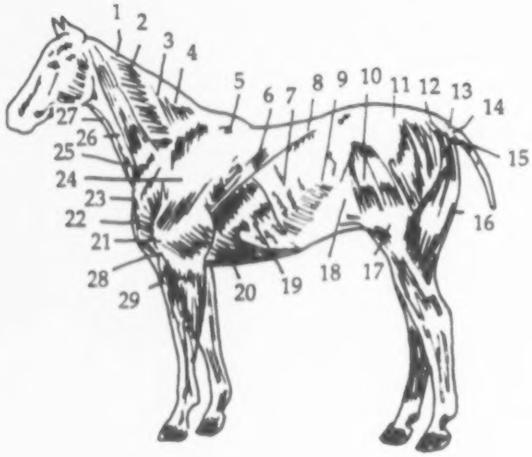
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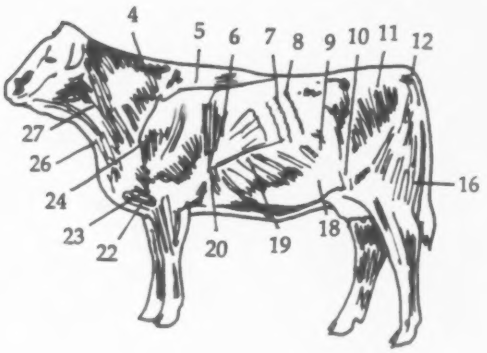
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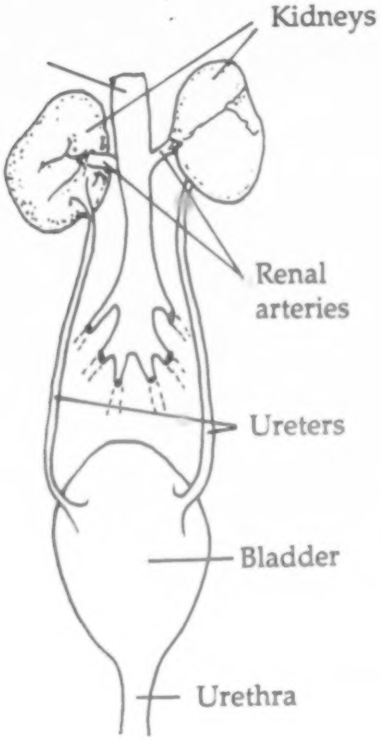
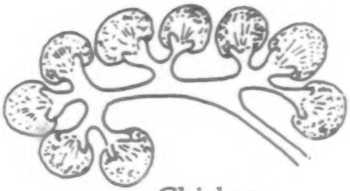
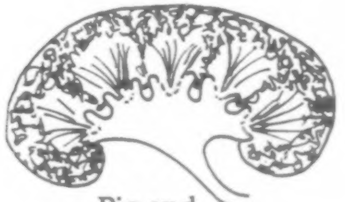
1. Rhomboideus
2. Cervical Cutaneus
3. Serratus Thoracis
4. Trapezius Cervicalis
5. Trapezius Thoracalis
6. Latissimus Dorsi
7. External Intercostal
8. Serratus Dorsalis
9. Obliquus Abdominis Externus
10. Tensor Fasciae Latae
11. Gluteus Superficialis
12. Biceps Femoris
13. Sacro-Coccygeus Dorsalis
14. Sacro-Coccygeus Internalis
15. Coccygeus
16. Semitendinosis
17. Fascia Lata
18. Aponeurosis
19. Serratus Thoracis
20. Posterior Deep Pectoral
21. Lateral Head of Triceps
22. Anterior Superficial Pectoral
23. Long Head of Triceps
24. Deltoid
25. Cervical Cutaneous Muscle
26. Brachiocephalicus
27. Sterno-Cephalicus
28. Extensor
29. Flexor

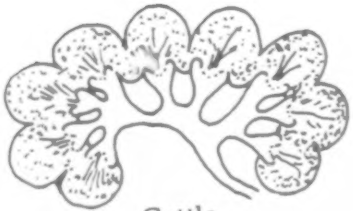
TRANSPARENCY MASTER #11

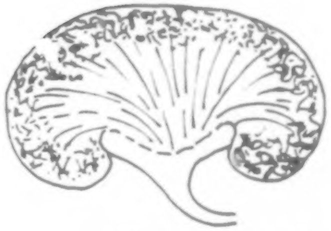
Excretory System and Shapes of Kidneys


Kidneys
Renal arteries
Ureters
Bladder
Urethra


Chicken

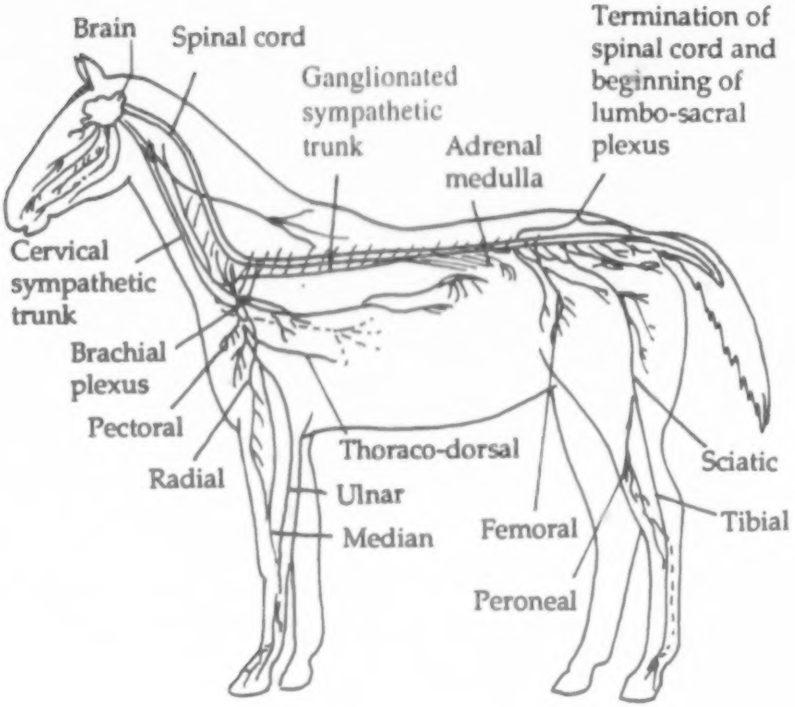

Pig and some dogs

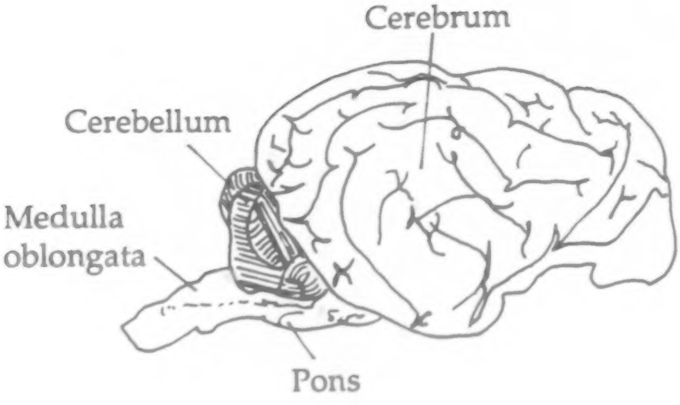

Cattle


Horse, cat, and some dogs

TRANSPARENCY MASTER #12

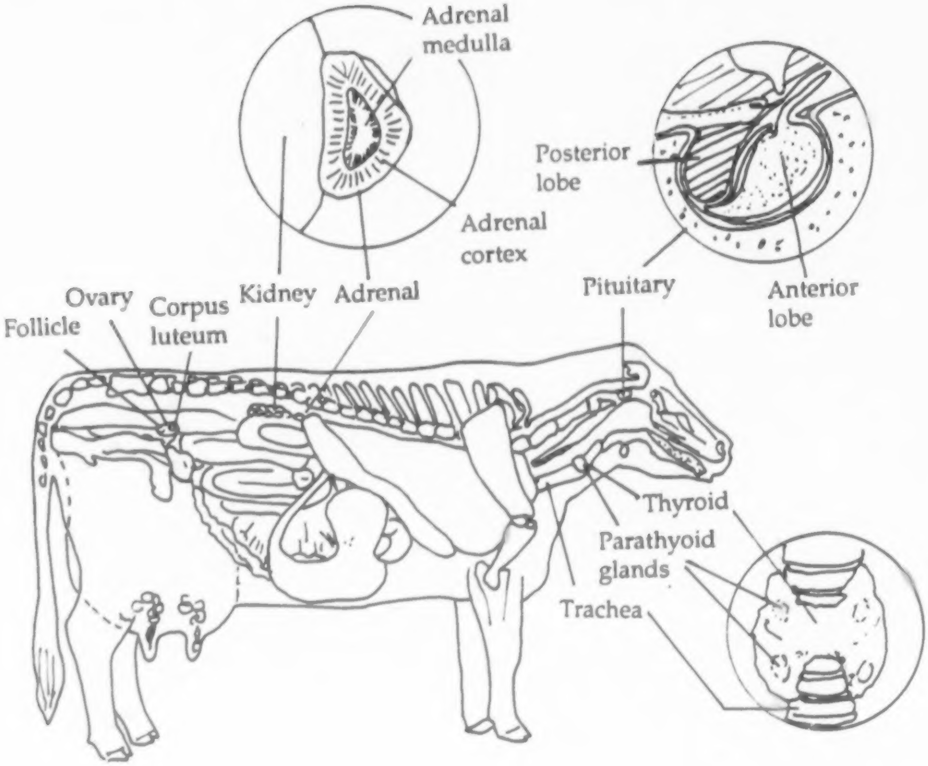
Nervous System of Domestic Animals and Anatomy of the Brain


Brain
Spinal cord
Ganglionated sympathetic trunk
Adrenal medulla
Termination of spinal cord and beginning of lumbo-sacral plexus
Cervical sympathetic trunk
Brachial plexus
Pectoral
Radial
Thoraco-dorsal
Ulnar
Median
Femoral
Peroneal
Sciatic
Tibial


Cerebrum
Cerebellum
Medulla oblongata
Pons

TRANSPARENCY MASTER #13

Endocrine System


Adrenal medulla
Posterior lobe
Adrenal cortex
Ovary
Follicle
Corpus luteum
Kidney
Adrenal
Pituitary
Anterior lobe
Thyroid
Parathyoid glands
Trachea

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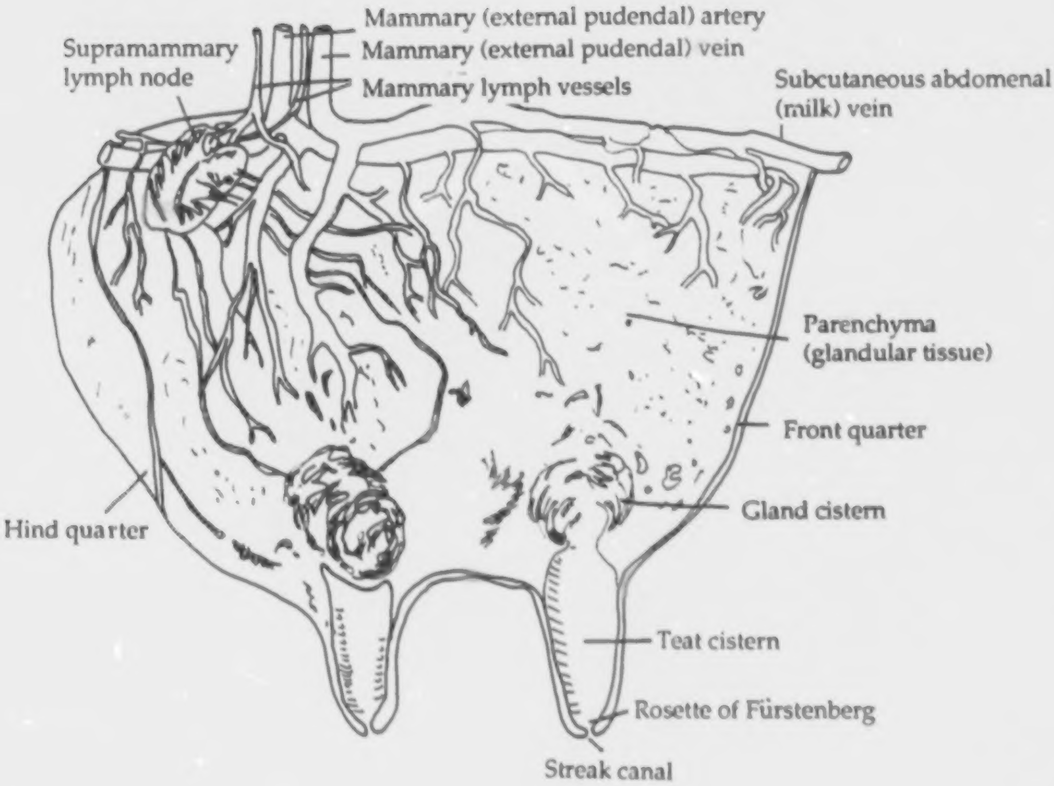
TRANSPARENCY MASTER #14

Sagittal Section of Udder of Cow


Supramammary lymph node
Mammary (external pudendal) artery
Mammary (external pudendal) vein
Mammary lymph vessels
Subcutaneous abdomenal (milk) vein
Parenchyma (glandular tissue)
Front quarter
Gland cistern
Hind quarter
Teat cistern
Rosette of Fürstenberg
Streak canal

TRANSPARENCY MASTER DISCUSSION GUIDES

Transparency Master #2

The integumentary system of animals consists of the exterior covering of the body and allied structures. This cover functions primarily for protection but also contains glands which help in temperature regulation and excretion of waste, and reception areas for stimuli such as touch, temperature, pain, and pressure. The skin contains two layers; the epidermis is the outer layer and has no blood cells, and the dermis is the inner layer and contains muscle fibers, nerves, blood vessels, sweat glands, and hair follicles. The epithelial tissue may be modified into hair, nails, claws, scales, and feathers.

Transparency Masters #3 and #4

The skeletal system of vertebrates is an internal body system; it is called an endoskeleton. The functions of bone are to provide protection and attachment of internal organs, to provide muscle attachment for form and rigidity, to store materials, and to provide for blood formation. The skeletal bones themselves are living cells and have blood vessels and nerves; are subject to disease; adjust to stress; and repair themselves. Approximately one-quarter of bone's weight comes from calcium and phosphorus which give rigidity and hardness. Another quarter of the weight comes from organic matter, and fifty percent comes from water.

Transparency Masters #5 and #6

The circulatory system consists of a four-chambered pump and a system of vessels for circulating blood which transports substances to and from the cellular level. The function of the blood is to maintain a stable environment in which the cells may function. This includes carrying oxygen, nutrients, and regulatory hormones to tissues and carrying carbon dioxide and metabolic wastes from tissues; another motor function of this reciprocal activity is to help maintain a relatively constant body temperature in warm-bodied animals. The circulatory system is found throughout the body, with most cells no more than three to four cells away from a blood capillary. The blood flows from the heart through arteries to the thin-walled capillaries, in which substance exchange occurs by diffusion; then the blood flows back through veins to the heart. Some fluid from the capillaries remains in the interstitial (between cells) area for a period of time. This fluid, called lymph, helps in controlling interstitial pressures and is a defense mechanism that filters out noxious material from the tissue fluid. The material is then destroyed, through phagocytization, by the leukocytes found in the lymph. This phagocytization activates antibody formation and assists in control of infection. The lymph is returned to the blood after passing through lymph vessels to enlarged lymph nodes where the phagocytization takes place.

The Cardiac Cycle

The cardiac cycle refers to the events that occur in sequence during one complete heartbeat. The arbitrary divisions include diastole and systole. Diastole refers to the period of relaxation which occurs during the filling of a chamber with blood. Systole refers to the contraction that takes place to empty the chamber. The sequence of events in the cardiac cycle is as follows.

1. Blood enters right atrium from systemic circulation and left atrium from lungs, during atrial diastole.
2. Filling occurs till pressure in atrium exceeds pressure in ventricles.
3. Atrium - ventricle (A-V) valves open to allow blood flow into ventricle.
4. Atria muscles contract (systole) forcing remaining blood into ventricle.
5. Atria relax (diastole). Greater pressure in ventricle forces A-V valve closed.
6. Ventricular pressure exceeds arterial pressure causing aortic (to body) and pulmonary (to lungs) valves to open.
7. Ventricular contraction (systole) occurs forcing blood from the left ventricle into the aorta and from the right ventricle into the pulmonary artery.
8. Ventricles relax (diastole) and arterial pressure exceeds ventricular pressure, forcing aortic and pulmonary valves shut (the second heart sound).
9. A-V valves still shut and blood begins to fill atria again.
10. Atrial pressure exceeds ventricular pressure and A-V valves open. Sequence starts over.

Transparency Master #7

The digestive system operates to reduce the food ingested to the basic nutrients simple enough to be taken up and used for energy and basic cell building. The processes include ingestion, grinding, digestion, and absorption. The anatomical systems involved include:

1. Mouth — includes the teeth and tongue for mastication, and salivary glands for lubrication and minimal digestion.

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2. Pharynx and esophagus — includes the fore stomachs of ruminants which contain bacteria for digestion, and passageway to true stomach.
3. Stomach — area of further mechanical breakdown, and chemical breakdown from addition of gastric juices.
4. Small intestine — area of further digestion by secretions from intestinal wall and pancreas, and bile from liver; main area of absorption of nutrients.
5. Large intestine (colon) — area of limited digestion and absorption of nutrients (modified in horses), and major absorption of water.
6. Rectum — end of colon; elimination of waste via the anus.

As can be seen this is a generalized summary and subject to modification for specific species.

Transparency Masters #8 and #9

The respiratory system is a means of conducting oxygen necessary for cellular metabolism (respiration) into the body and conducting carbon dioxide (a by-product of cellular metabolism) out of the body. This pulmonary system begins with the passage provided by the nostrils and nasal cavity. The larynx, trachea, and bronchial tubes conduct the air into the lungs. Within the lungs are the bronchioles which contain the alveoli where the actual gas exchange takes place. Blood cells, via hemoglobin, transport the oxygen to the cellular level and exchange it for carbon dioxide. The transport process then reverses.

Secondary functions of this system include assistance in temperature control, elimination of water, voice (sound) production and extracellular fluid acidity regulation. Again, variations are found within specific species.

Transparency Master #10

The muscular system consists of highly specialized cells with the function of contraction. This contraction provides not only motion and mobility but also the means of maintaining cellular and tissue functions. These functions include walking, transport, breathing; ingestion, digestion and elimination of food; blood circulation and reproductive activities. The contraction process involves energy and the expenditure of ATP. Three forms of muscle tissue are found. Skeletal muscle moves limbs and body parts. Cardiac muscles are found in the heart and serve to pump blood. Smooth muscles move material in the digestive tract, help maintain breathing, and manipulate glands for secretion.

Transparency Master #11

The excretory system is responsible for assimilation and excretion of the waste products of cell metabolism. In connection with the excretion of waste is the maintenance of a relatively constant internal environment of the body, homeostasis. Among those factors regulated are pH, water balance, electrolyte levels, osmotic pressure, and the concentration of various substances. The urinary system is a somewhat narrower term than excretory system and includes: the kidneys, which filter plasma; the ureters, which pass urine from the kidneys to the bladder; the bladder, in which urine is temporarily stored; and the urethra, which passes the urine outside the body. The kidneys will selectively reabsorb water and certain nutrients from the filtered plasma; the remainder, mostly water and urea, is what comprises urine. The bladder shape of various species does differ. The excretory system includes the egestion (opposite of ingestion) of undigested materials by the digestive system (feces), the elimination of carbon dioxide by the lungs, and elimination of soluble wastes by the sweat glands.

Transparency Master #12

The nervous system is a means for an organism to have contact with its environment. Specialized cells, such as sensory, serve to conduct stimuli from the environment to the central nervous system. These are afferent cells. The central nervous system then conducts impulses by the efferent cells to the area of response.

The central nervous system is the term used to designate the brain and the spinal cord. This system serves to interpret and integrate incoming stimuli.

The peripheral nervous system contains all nerves outside the central nervous system. The peripheral system is capable of interpretation and formulating responses. The peripheral system is divided into the somatic system and autosomatic system. The somatic system is comprised of the voluntary functions such as skeletal muscle contraction.

The autonomic system is subdivided into the sympathetic and parasymphathetic. The sympathetic system activates bodily functions in response to stressful stimuli, for example, releasing epinephrine. The parasympathetic is concerned with maintaining internal homeostasis, for example, decreasing the heart rate. The two systems tend to counteract each other.

Transparency Master #13

The endocrine system is composed of glands that are ductless. Ductless glands secrete substances directly into the blood stream. These substances, hormones, are chemical messengers that coordinate and regulate the growth or activity of the target cells. Since endocrine glands are ductless these glands contain a high amount of vascularization. The endocrine system is allied with the nervous system in that stimuli are conducted to the glands, and is similar to the nervous system in regulating functions, though its effect is slower in action and more general in nature.

Exocrine glands are multicelled glands that have ducts that deliver secretions to a particular point. An example would be the liver which uses the common bile duct to deliver digestive secretions to the duodenum. Species variations are numerous.

Examples of glands include the following:

1. Endocrine glands — hormones secreted.
2. Thyroid — secretes thyroxin that regulates overall metabolic activity.
3. Parathyroid — secretes parathormone that stimulates release of calcium and phosphorus from bones.
4. Adrenals — have two sections; the medulla whose inner portion secretes epinephrine; and the cortex whose outer portion secrets fifty hormones known as steroids.
5. Pituitary — has two sections; the posterior secretes pituitrin which raises blood pressure and causes smooth muscle contraction; and the anterior which secretes prolactin, a milk production growth hormone that assists organ and tissue development, a follicle-stimulating hormone that stimulates ovaries to release ova, a thyroid-stimulating hormone that stimulates the adrenal cortex to secrete cortisol, and a luteinizing hormone to stimulate corpus luteum formation.
6. Ovaries — secrete estrogen to control menstrual cycle and progesterone to maintain pregnancy.
7. Testes — secrete testosterone to maintain masculinity.
8. Pancreas — exocrine gland, secretes insulin to take up glucose and store it as glycogen, glucagon to break down glycogen, and bicarbonates.
9. Intestinal mucosa — secretion that is carried to the pancreas and stimulates the release of juices rich in bicarbonates to reduce stomach acidity.

Transparency Master #14

The mammary glands are peculiar to those organisms, the mammals, that bear live young. These glands are modified sweat glands and develop in a line (the milk line) parallel to the medial axis. In the domesticated animals, the bitch and sow develop glands along the entire length of the milk line and the remaining animals only the most caudal develop.

The development of the mammary system is associated with puberty. The ovarian hormones responsible for development of the duct system; progesterone, in combination with estrogen, is needed for alveolar development. The anterior pituitary is also involved with mammary gland development, not only indirectly as the control of the ovarian hormones, but also directly through the production of prolactin and somatotrophin (growth hormone). In addition the anterior pituitary exerts direct control of the thyroid and adrenal cortex thus affecting the metabolic activities of the alveolus.

The alveoli are secretory epithelium cells and differ from the other exocrine glands in that secretory cells are found throughout the gland not just at the end of the smallest ducts. The alveoli are responsible for breaking down or synthesizing the components found in milk. Milk fats are synthesized in ruminants by breaking down fatty acids, or acetate ; and in nonruminants by using glucose as a substrate. Lactose, milk sugar, is found only in milk and glucose presumably is used in synthesis. Casein, milk protein, is found only in milk, and is constructed by linking amino acids with peptides, by degradation of blood plasma proteins, by the rearrangement of peptide chains in plasma proteins, or by all three methods.

The mammary gland is arranged with each quarter as a separate entity and each half (right half, left half) being almost completely independent in blood and nerve supply. The suspensory apparatus is essentially independent for each quarter with the halves having a common medial suspensory ligament, mostly yellow connective tissue, and each half having lateral suspensory ligaments, mostly white connective tissue.

The differences in mammary glands among species include not only the number of divisions but also teat arrangement. Swine generally have 7 pairs or 14 teats with each teat having two streak canals and two teat cisterns. Goats and sheep have their mammary gland divided into two halves with each half having a teat with only one streak canal, gland cistern, and teat cistern. Horses' mammary glands consist of two halves with each half having a teat with two streak canals and two teat cisterns, each with its own system of ducts and alveoli. Cows have the two halves divided (thus four quarters) each with one teat, streak canal, teat cistern, gland cistern, and system of ducts and alveoli.

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STUDENT ACTIVITIES

STUDENT WORKSHEET #1 — Ruminating on Ruminants

For additional activities, teachers may refer to the "Suggested Teaching Activities and Procedures" section in the Instructor's Guide.

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STUDENT WORKSHEET #1

Ruminating on Ruminants

Background

Much criticism is directed toward food animals on the grounds that they are inefficient processors of energy. It is repeatedly pointed out that several pounds of grain are required to produce one pound of edible animal product. In a world in which starvation and undernourishment are prevalent, the disadvantages of consuming animal rather than vegetable seem apparent.

In the face of this continuing anti-animal criticism, it is important to understand and to emphasize the important role which ruminants play and the appropriate place which they command in the food chain. Ruminants possess the important property of being able to convert grasses and other fibrous plants (roughages), which are virtually inedible, to highly nutrious meat and dairy products In the process, proteins are produced which are much more complete or well balanced in terms of amino acid composition than are typical vegetable proteins.

The roughage conversion process is important because there are times and places where the growth of roughages is either necessary or highly desirable. On range and rough land only roughage crops can be grown. On rolling land, grass strips help control erosion. On all row-crop land periodic planting of a roughage crop helps improve soil tilth and controls diseases. The ruminant animal provides a means of harvesting this crop.

The ruminant is able to convert roughage to meat or milk because it possesses a specialized series of stomachs capable of digesting the fibrous materials that simple-stomached animals like man cannot. The heart of the process resides in the rumen, the largest of the four stomach chambers. Here a population of resident bacteria break down the cellulose in the plant cell walls, converting it to simpler sugars and freeing the contents of the cell for digestion. The products, including many of the bacteria, are then processed in the other stomachs.

Problem

Demonstrate the four-compartment ruminant stomach, show some of the species of bacteria which populate it, and explain some of the functions they perform. What are the differences in ruminant digestibility of fibrous materials in vitro?

Materials and Methods

The four-compartment ruminant stomach system could be shown in diagram, or, with a little more work, a three-dimensional model could be made. A microscope could be set up showing some species of rumen bacteria and protozoa. These could be obtained from fistulated animals at the Univeristy of Illinois or other animal research centers, from rumens in a slaughter house, or from live animals by stomach tube, with the cooperation of a local veterinarian. Digestion demonstrations could be set up in small flasks containing rumen fluid. Differential digestion of fibrous materials could be examined by placing samples of cotton, cardboard, leafy alfalfa, etc., in separate flasks. The flasks should be at 37°C. To achieve anaerobic digestion, they should have an air lock such as can be obtained at wine-making stores.

Activity

After following the directions above have the students compare the activity of the rumen bacteria on the chosen fibrous materials. A comparison could also be made between the fibrous materials used in the demonstrations to that normally consumed by a ruminant. Pairs or groups of students could be matched to prepare oral or written reports.

Taken from *The Science Workbook of Student Research Projects in Food, Agriculture and Natural Resrouces.* Hines, Dr. H.C. Department of Dairy Science, The Ohio State University, 2027 Coffey Road, Columbus, Ohio 43210. Published by The Ohio State University.

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Meeting Nutritional Needs of Animals

RELATED PROBLEM AREAS:

1. Identify Basic Principles of Animal Science (Central Core Cluster)
2. Understanding Animal Anatomy and Physiology
3. Maintaining Animal Health
4. Caring for Animals
5. Understanding Animal Breeding and Reproduction

PREREQUISITE PROBLEM AREA(S): None

LEVEL: Preparatory

OCCUPATIONAL TASKS ADDRESSED:

Agricultural Business and Management Cluster

Duty A: Formulating Livestock Feeding Programs

1. Assess livestock needs, such as growing and fattening, nursing, production, or specific nutritional needs
2. Identify feed formula for livestock needs
3. Balance rations
4. Substitute feed ingredients
5. Mix feed additives and medications
6. Analyze feed nutritional value
7. Compute feed cost per pound gain
8. Evaluate feeding program
9. Plan feeding program
10. Record daily feed consumption

Duty H: Managing the Business

1. Maintain animal records

Duty N: Breeding, Handling, and Caring for Animals

1. Feed animals using conventional methods

STATE GOALS FOR LEARNING

In planning the instruction for this problem area, teachers can promote the development of several student learning objectives which are related to the State Goals for Learning in Biological and Physical Sciences and in Physical Development and Health. These objectives are listed on the Learning Assessment Plan forms included on the following page(s). Those learning objectives marked with an asterisk (*) are taken from the sample lists provided by the Illinois State Board of Education.

Illinois Agricultural Core Curriculum
Agricultural Education 124 Mumford Hall 1301 W. Gregory Drive University of Illinois Urbana, IL 61801

Director: Dale A. Law, Ed.D.
Principal Investigator: Jerry D. Pepple, Ed.D.
Research Assistant: Robert E. Petrea

Submission Date ____________

☐ Original submission ☐ Revision

Page ____ of ____

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)

COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐

District Name

City

I. LEARNING AREA *(check one)*

☐ Language Arts
☐ Mathematics
☒ Sciences
☐ Fine Arts
☐ Social Sciences
☐ Physical Development/Health

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will have a working knowledge of the social and environmental implications and limitations of technological development.

Contact Person: ____________

Title: ____________

Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Analyze the properties of water that cause it to be vital to an ecosystem.					
2. Name the classes of nutrients and describe the function of each.					

ISBE 41-78 (1/88)

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

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Page ____ of ____

(Affix label or complete district information.)

COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐

District Name

City

Contact Person: ____________________

Title: ____________________

Phone: ( )

I. LEARNING AREA *(check one)*

☐ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☐ Sciences ☒ Physical Development/Health

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able understand principles of nutrition, exercise, efficient management of emotional stress, positive self-concept development, drug use and abuse, and the prevention and treatment of illness.

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Understand nutritional concepts used in selecting balanced diets.					
2. List and explain the functions of the major parts of the digestive system.					
3. Name the classes of nutrients and describe the function of each,					

ISBE 41-78 (1/88)

Illinois Agricultural Core Curriculum Rev.

Submission Date ____________________
☐ Original submission ☐ Revision
Page ____ of ____

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☒ Sciences ☐ Physical Development/Health

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)
COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐
District Name
City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will have a working knowledge of the concepts and basic vocabulary of biological, physical and environmental sciences and their application to life and work in society.

Contact Person: ____________________
Title: ____________________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Relate the processes by which organisms capture, utilize, and release energy. *2. Understand major body systems.					
*3. Understand that complex animals carry out vital processes within organ systems which are separate in function but mutually dependent.					
*4. Recognize basic animal systems using preserved specimens. *5. Identify and describe functions of tissues and organs.					
6. Define terms integral to animal nutrition and digestion.					
7. List and explain the functions of the major parts of the digestive system.					
8. Compare and contrast the ruminant and nonruminant stomach.					
9. Name the classes of nutrients and describes the function of each.					
10. Identify systems or organs as being polygastric or monogastric from slides or specimens.					491

Meeting Nutritional Needs of Animals

Agricultural Business and Management
Animal Science

ISBE 41-78 (1/88)

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Meeting Nutritional Needs of Animals

STUDENT LEARNING OBJECTIVES

Upon completion of their study of this problem area, students will be able to:

1. Define terms integral to animal nutrition and digestion.
2. List and explain the functions of the major parts of the digestive system.
3. Compare and contrast the ruminant and non-ruminant stomach.
4. Name the classes of nutrients and describe the function of each.
5. Explain the characteristics of a good ration.
6. Demonstrate the use of the Pearson Square method in determining the protein content of a ration.
7. Describe an example ration for specific species of animals.
8. Identify systems and organs as being polygastric or monogastric from slides and specimens.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Meeting Nutritional Needs of Animals

PROBLEMS AND QUESTIONS FOR STUDY

1. What is the digestive system?
2. How does the digestive system function?
3. What are the parts of the digestive system?
4. What is a ruminant stomach?
5. How does a polygastric stomach differ from a monogastric stomach?
6. What is a ration?
7. What is a balanced ration?
8. What are nutrients?
9. Why are nutrients important?
10. What is the function of each of the nutrients?
11. What is the difference between a concentrate and a roughage?
12. How is the Pearson Square method used to balance a ration?
13. What factors need to be considered when balancing a ration?
14. How does age affect the ration needed?
15. How does sex affect the ration needed?
16. How does the stage of gestation affect the ration needed?

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Meeting Nutritional Needs of Animals

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES

1. Use community resource people for guest lecturers, such as cooperative extension personnel, feed company representatives, production facility managers, and veterinarians to address students on the necessity of proper nutrition.

2. Use appropriate VAS and Instructional Materials Service publications as references and resources for student study guides.

3. Have students collect feed labels and discuss what information is found on the labels and how the information should be used in formulating a ration.

4. Use VAS Transparency Set #T131 as an instructional aid for content delivery and as a resource for study guides and sample rations for various animals.

5. Conduct field trips to feed stores and production facilities to see the means and methods of providing rations to animals.

6. Have students collect roughages from the local community. Use feed tables to estimate the nutritional value of the roughages and then formulate a ration for a specific animal using the roughages and feed labels.

7. Have students take a survey of feedstuffs for animals in their home and compare those labels with recommendations for those animals.

8. Divide the class into small groups and assign a different species to each group. Have the groups investigate the nutritional requirements for each group and prepare a report to the class. Lead the class in a discussion of the similarities and differences in the requirements.

9. Have students incorporate the subject matter content into SAE programs.

10. Obtain computer programs, such as *Dairy Ration Balancing* (HOBAR) or *Ration Master* (Agri-Farm) for use by the class as references and study guides and for use in student evaluations.

11. Obtain life action videos on nutrition topics. Possible sources:

    a. Teaching Aids, Inc.
    Box 1798
    Costa Mesa, CA 92628

    b. Photo Com
    Box 3135
    Pismo Beach, CA 93449

12. Use local facilities such as packing plants, production facilities, state animal laboratories, university research laboratories, or veterinarians as resources where digestive tracts from various species may be observed and compared.

13. Lead the class in a discussion of the various feedstuffs that are used locally as alternatives to those suggested in the resource material.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Meeting Nutritional Needs of Animals

REFERENCES

*1. *Animal Science.* (1983). Ensminger, M.E. Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

*2. *The Stockmans Handbook.* (1983). Ensminger, M.E. Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

*3. *Managing the Beef Cow Herd* (VAS Unit #U1010B); *General Facts on Livestock Feeding* (VAS Unit #U1013A); *Feeding Dairy Cattle* (VAS Unit #U1020B); *Swine Feeds and Feeding* (VAS Unit #U1036A); *Caring for the Brood Mare and Foal* (VAS Unit #U1041); *Feeding and Managing Sheep and Lambs* (VAS Unit #U1060); *Feeding and Care of Dogs* (VAS Unit #U1062); *Feed Additives and Hormone Implants in Animal Agriculture* (VAS Unit #U1063); *Feed Rations for Swine* (VAS Unit #U1064); *Horse Feeding and Nutrition* (VAS Filmstrip #F152); *Digestion in Swine* (VAS Filmstrip #F170); *Animal Nutrition* (VAS Transparency Set #T131); *Livestock Program* (VAS Computer Program #CP108). Vocational Agriculture Service, College of Agriculture, University of Illinois, 1401 S. Maryland Drive, Urbana, IL 61801.

*4. *Livestock, Dairy and Poultry Production* (Subject Matter Unit #8642-A); *Feed Nutrients* (Subject Matter Unit #8647-A). Instructional Materials Service, Texas A & M University, P.O. Box 2588, College Station, TX 77843-2588. (409) 845-6601.

5. HOBAR Publications, 1234 Tiller Lane, St. Paul, MN 55112. (612) 633-3170.

6. Agri-Farm Publications, 1019 Market Street, P.O. Box 43, Gowrie, IA 50543. (515) 352-3303.

7. *Rabbit Production.* (1968). Cheeke, P.R., Patton, N.M., Templeton, G.S. Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

8. *Modern Mink Management.* (1968). Leonard, Albert. Ralston Purina Co., Checker Board Square, St. Louis, MO 63199.

9. Illinois State Rabbit Breeders Assn, Inc., 190 N. First Ave., Coal City, IL 60416. (815) 634-4788.

10. Mink Breeder's Assn. of Illinois, 38614 N. Fairfield Road, Lake Villa, IL 60046.

11. *The Yearbook of Agriculture - 1978, Living on a Few Acres.* The U.S. Department of Agriculture, Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

12. *The Yearbook of Agriculture - 1984, Animal Health — Livestock and Pets.* The U.S. Department of Agriculture, Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

*Indicates highly recommended reference

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTIONAL RESOURCES

These resources are intended for use by teachers in planning and teaching the materials for this problem area and may be adapted to fit the teaching method(s) used.

INFORMATION SHEET #1 — How Should a Cat be Fed?

INFORMATION SHEET #2 — How Should a Dog be Fed?

INFORMATION SHEET #3 — Animal Nutrition

INFORMATION SHEET #4 — Dairy Cow Requirements and Sample Ration

INFORMATION SHEET #5 — Nutritional Requirements of Rabbits and Mink

TRANSPARENCY MASTER #1 — Two Types of Digestive Systems (with dicussion guide)

TRANSPARENCY MASTER #2 — Digestive System of the Cow (with dicussion guide)

TRANSPARENCY MASTER #3 — Digestive System of the Sow (with dicussion guide)

TRANSPARENCY MASTER #4 — Digestive System of the Horse (with dicussion guide)

TRANSPARENCY MASTER #5 — Digestive System of the Chicken (with dicussion guide)

TRANSPARENCY MASTER #6 — Some Functional Differences Between Ruminants and Nonruminants (with dicussion guide)

TRANSPARENCY MASTER #7 — Approximate Average Capacities of Digestive Systems (with dicussion guide)

TRANSPARENCY MASTER #8 — Functions of the Rumen and Reticulum (with dicussion guide)

TRANSPARENCY MASTER #9 — Functions of the Omasum and Abomasum

TRANSPARENCY MASTER #10 — Functions of the Duodenum, Small Intestine, Large Intestine, and Anus

TRANSPARENCY MASTER #11 — Functions of the Cecum

TRANSPARENCY MASTER #12 — Pathway of Feed in Both Digestive Systems (with dicussion guide)

TRANSPARENCY MASTER #13 — Comparison of Nutrient Content for a Concentrate and a Roughage (with dicussion guide)

TRANSPARENCY MASTER #14 — Pearson Square (with dicussion guide)

TRANSPARENCY MASTER #15 — How to Use the Square Method (with dicussion guide)

TRANSPARENCY MASTER #16 — Using the Square Method to Combine Several Feed Ingredients (with dicussion guide)

INFORMATION SHEET #1

How Should a Cat be Fed?

Cats, like humans, are omnivorous. They eat meat but need vegetables, also, to have a balanced meal. Cats need a high-protein, high-fat diet for good growth. If you want to be sure your cat is getting good nutrition, buy a commercial cat food. Companies have been testing and improving their products until they meet or exceed the needs of each cat. There are four major divisions of commercial cat food available:

1. Dry cat food contains about 30 percent protein, 8 percent fat, and 9 to 10 percent moisture. For adult cats, feed 1 to 1 1/2 ounces twice a day.

2. Specialty cat food, in the little flat cans, usually contains from 10 to 23 percent protein, 2 percent to 6 percent fat, and about 75 percent moisture. Vitamins and minerals are added to balance the nutrition. Adult cats should be fed 2 1/2 to 4 ounces of the food twice a day.

3. Maintenance cat food, in the tall cans, usually contains about 10 percent protein, at least 2 percent fat, and about 75 percent moisture.

4. Soft-moist cat food is the pouch-packaged food. It normally contains at least 27 percent protein, 7 percent fat, and 30 to 34 percent moisture. One packet provides one feeding for the adult cat. Feed twice a day.

There are some "do nots" to remember in feeding your cat. First, do not feed your cat table scraps. He may like them but they lack the balanced nutrition he needs. Also bones from the table scraps can be hazardous. Second, do not feed him the same things every day. He wants variety; give it to him. Some foods can be toxic if given often. Liver can cause vitamin A toxicity, raw egg white can destroy the vitamin biotin, and raw fish can cause a deficiency of the vitamin thiamine.

When feeding a cat, always have a dish or bowl of fresh, clean water available. This is very important. You must remember also that milk is not a substitute for water; milk is a food. Regularity is another good point; the cat should be fed at the same times each day, or else the irregularity will affect the cat in a detrimental way.

Kittens must be considered separately from adult cats. For six- to eight-week-old kittens, a mixture of warm milk and a little regular cat food will serve as a good starter meal. Then, gradually reduce the milk and increase the cat food until the kitten is eating only the cat food. This takes about two weeks. Kittens need a different eating schedule, too. They should be fed four times a day, instead of two, because of their small stomachs.

Cats are creatures of comfort. They like to be warm and cozy; in other words, they like to stay in the house.

INFORMATION SHEET #2

How Should a Dog be Fed?

Before feeding any animal, a person must consider what its requirements are for good nutrition. The nutritional requirements for a dog as stated by the National Research Council are:

National Research Council Recommendation*

Nutrient	Percent
Dry Matter	28.0
Protein	6.7
Carbohydrate (maximum)	20.0
Fat	1.5
Fiber	NR
Ash	NR
Calcium	0.3
Phosphorus	0.24
Potassium	0.24
Sodium Chloride	0.43
Magnesium	0.014

Nutrient	Mg Per Lb of Feed
Iron	7.0
Copper	1.0
Cobalt	0.3
Manganese	0.6
Zinc	0.6
Iodine	0.6
Vitamin A	600 IU
Vitamin D	40 IU
Vitamin E (Alpha Tocopherol)	6.0
Vitamin B-12	0.003
Folic Acid	0.02
Riboflavin	0.24
Pyridoxine (B-6)	0.12
Pantotenic Acid	0.3
Niacin	1.3
Choline	150.0

*Based on NRC Requirements of Dogs — revised 1962 — Table 1 — "Nutrient Requirements of Dogs"

Another consideration is the stage of growth of the dog. Puppies need a feed that has a higher percentage of certain nutrients than full grown dogs (refer to the Puppy Chow commercial on television). Commercial feeds are readily available that fill the nutritional requirements of these animals. In addition, the information on requirements and foodstuffs that are used to fill these requirements is found on the can or package of every dog food product.

Dividing dogs into two separate groups is the best way to present the feeding schedules and the amount of feed for each animal, as related to the age of the dog.

Puppies have special feeding requirements. They are:

1. For puppies three to four weeks old — In addition to feeding by nursing, the puppies should be offered a gruel of one part water, milk, or broth and one part puppy food, twice a day. Regulate the amounts at about 1 ounce per pound of body weight, because a puppy's eyes are often bigger than its stomach.

2. For puppies five to seven weeks old — At this point the mother should begin weaning the pups. The amount of puppy food in the gruel should increase to two parts feed to one part water. The number of meals per day should increase because the puppies are receiving less nourishment from their mother. The daily amount of feed will vary according to body weight. The rule of thumb is to feed 1 ounce per pound of body weight, divided into two to three feedings per day.

3. For puppies seven weeks to three months of age and completely weaned — The amount of feed should be increased proportionally with the puppies' weight, and the number of feedings should also increase to three to four times a day.

4. For puppies three to six months old — The number of feedings should decrease to three a day during this period of rapid growth. Do not be surprised if the pups double their weight during this period. Feed them all they can eat.

5. For puppies six to twelve months old — The feedings per day can be dropped to two, because a puppy's stomach has a greater capacity and his growth rate is leveling out.

When feeding the adult dog, there are several areas to consider:

1. Do you want to feed dry or canned dog food? Dry dog food contains about 23 percent protein, 7 percent fat, 24 percent carbohydrates, and about 10 percent water. This type of feed will deliver from 1,650 to 2,000 kilocalories per pound. It is balanced in all nutrients, and can be served dry, moist, or mixed with other foods.

2. Canned dog food contains about 10 percent protein, 4 percent fat, 8 percent carbohydrates, and up to 75 percent water. This type will deliver 650 to 700 calories per pound.

3. How much, and how often should the adult dog be fed? A good rule in feeding adult dogs is to feed 1/2 ounce of dry dog food per pound of the dog's weight per day. Adjustments must be made when serving canned dog food because it is about 75 percent water. So when feeding canned dog food, the amount should increase to1 or 1 1/2 ounces per pound of the dog's weight per day.

4. An adult dog only needs to be fed once a day to satisfy its hunger. The best time to feed the dog is just before the owner's dinner time so the dog will not beg for food while the owner is eating.

If the owner decides to give a bone to his dog, should he first consider the type of bone he plans to give to the dog? Most bones are small and splinter easily when chewed by a dog. Large bones like shanks or knuckles are the best, with chicken and fish bones the least desirable bones. The bone does little to add to the nutrition of the dog, it only helps to clean the tartar off his teeth.

When feeding the pregnant dog, the bitch requires a small increase in food consumption. What needs to be watched carefully is the nutrient quality of the ration. The owner should use a quality tested feed that fills the nutritional needs of the bitch. After she has given birth, the bitch needs additional food to produce milk for her pups. When her pups are four weeks old, she will need about double her pregnant ration to continue producing enough milk for the litter.

When the puppies are to be weaned after about six weeks of nursing, be sure the pups are eating solid food. Cut the ration of the female according to the following schedule to help her dry her teats:

1st day	no food
2nd day	one-fifth her normal ration
3rd day	two-fifths her normal ration
4th day	three-fifths her normal ration
5th day	four-fifths her normal ration
6th day	she should be back on her pre-pregnant feeding schedule

When feeding field or working dogs, a special emphasis needs to be put on the amount of energy used by the animals. These dogs burn a tremendous amount of energy, so extra calories need to be added to their diet. A possible solution would be to add meat to the diet along with the regular dog food. This would help increase the appetite and increase caloric intake. The addition of fats, such as lard, bacon grease, or corn oil, will also increase the amount of energy consumed, raising the caloric intake.

The dog owner should stick to commercial dog food because of the problems that can occur by feeding the animal improperly. For example, milk, when given to an adult dog, can cause diarrhea, and raw eggs contain an enzyme that destroys the vitamin biotin.

INFORMATION SHEET #3

Animal Nutrition

Good nutrition is one of the basic considerations of modern livestock production. Good nutrition involves the wise use of available feedstuffs in formulating a palatable, least-cost, and nutritionally balanced ration for livestock. Today's livestock producer should be familiar with the basic concepts of good nutrition.

The costs associated with the production of livestock include: purchase price of breeding or feeder stock, buildings, equipment, land, feed, labor, interest on capital investment, etc. The largest of these expenses is feed. It may range from 60 to 80 percent of the total production cost.

Animals must have the **nutrients** provided by feed ingredients in order to survive. Feed ingredients are divided into six types: carbohydrates, fats, proteins, minerals, vitamins, and water. These nutrients are used for **maintenance, growth, production, and pregnancy**. Nutrients may be defined as: "The chemical substances found in feed materials that are necessary for proper body functioning." Nutrients found in feeds are not immediately available for use by the animal's body. These nutrients must be changed through the essential body processes into a usable form. These processes are **digestion, absorption, and metabolism.**

1. **Digestion is:** "The process in which feed particles are physically broken down and chemically converted into food nutrients that can be absorbed. It includes all activities of the digestive tract and its glands." Digestion begins immediately after **prehension** (the act of bringing food into the mouth) and ends when the nutrient is absorbed into the animal's blood stream. **Mastication** is the act of chewing food. It involves the physical grinding and tearing of feed into small particles. **Saliva** is added which begins certain enzyme reactions. Additional acids and digestive secretions are added by other parts of the digestive tract to aid in digestion.

2. **Absorption is:** "The process by which food nutrients enter the animal's bloodstream." Absorption occurs primarily in the small intestine. Some absorption occurs in the large intestine, the rumen in most ruminants, and the cecum in horses. Microscopic fingerlike protrusions called **villi** line the walls of the small intestine. Nutrients are carried into the villi by **active transport and osmosis.** They are then carried by capillaries (tiny blood vessels) into the blood stream, and then to all parts of the body.

3. **Metabolism is:** "The sum of all the processes and changes that take place in food nutrients after they have been absorbed from the digestive tract." These processes take place in every cell of the body. They include both the "building up" process (anabolism) in which nutrients are used for formation and repair of body tissues; and the "breaking down" processes (catabolism) in which nutrients are used for the production of heat and work.

INFORMATION SHEET #4

Dairy Cow Requirements and Sample Ration

Maintenance of a 1300-lb cow				
DP (lb)	NE_{lc} (Mcal)	Ca (lb)	P (lb)	Carotene (mg)
.75	10.20	.048	.037	62.8

	DP (lb)	NE_{lc} (Mcal)	Ca (lb)	P (lb)	Carotene (mg)
Maintenance	.75	10.20	.048	.037	62.8
50 lb milk (3.5%)	2.40	15.65	.130	.095	—
Totals	3.15	25.85	.178	.132	62.8

Ingredient	Amount fed (lb)	DP (lb)	NE_{lc} (Mcal)	Ca (lb)	P (lb)	Carotene (mg)
Corn silage	50	.70	11.00	.040	.300	—
Alfalfa hay	10	1.14	5.10	.113	.021	519.0
Totals from forage		1.84	16.10	.153	.051	519.0
Amounts required		3.15	25.85	.178	.132	62.8
Needed in concentrate mix		1.31	9.75	.025	.081	0.0

SAMPLE RATION						
Ingredient	lb/day	DP (lb)	NE_{lc} (Mcal)	Ca (lb)	P (lb)	Carotene (mg)
Corn silage (28% DM)	50.00	.700	11.000	.040	.030	—
Alfalfa hay (early bloom)	10.00	1.140	5.100	.113	.021	519.0
Corn, dent #2	8.50	.570	8.330	.002	.026	—
Soybean meal (44% sol.)	2.00	.780	1.680	.006	.013	—
Dicalcium phosphate	.24	.053	.043			
Salt (free-choice)	—	—	—	—	—	—
Totals		3.190	26.110	.214	.133	519.0
Required		3.150	25.850	.178	.132	62.8

INFORMATION SHEET #5

Nutritional Requirements of Rabbits and Mink

		Class of Rabbit				
Nutrient	Unit	Growing 4-12 Weeks	Lac-tation	Ges-tation	Mainte-nance	Does and Litters Fed On Diet
Crude protein	%	15	18	18	13	17
Crude fiber	%	14	12	14	15-16	14
Indigestible fiber	%	12	10	12	13	12
Digestible energy	kcal/kg	2500	2700	2500	2200	2500
Metabolizable energy	kcal/kg	2400	2600	2400	2120	2410
Fat	%	3	5	3	3	3
Minerals						
Calcium	%	0.5	1.1	0.8	0.6	1.1
Phosphorous	%	0.3	0.8	0.5	0.4	0.8

Rabbits have shown a preference for pelleted feed over that prepared as a mash. If a mash is prepared and fed, coarsely ground or rolled grains should be used and molasses added to aid palatability and retard spoilage. For backyard raising, green feeds and succulents can be added to reduce the pelleted feed amount. Greens can make up to about 50% of the diet, but it must be remembered that most greens and succulents are between 80 to 90% water and rabbits prefer the leaves and flowers. Succulents should be fed from the top of the cage or in special feeder, NOT in piles. For more specifc information you can contact the Illinois State Rabbit Breeders Association.

Mink

The mink is more carnivorous than most other domestic animals. The mink has a short digestive tract with a digestion time of 2-4 hours. The stomach is small and several small feedings are required instead of one large feeding. Recommendations vary from 25 to 40 percent for the amount of commercial feed that should be contained in the ration. Commercial feeds furnish carbohydrates (grains), most vitamins (high amounts of both fat-soluble and water-soluble vitamins are needed), and minerals. Most of the protein and fats within mink rations come from fresh or frozen meat, fish, poultry, and dairy products. There are many characteristics to consider when deciding which fresh or frozen product to choose. For more specific information you can contact the Mink Breeders Association of Illinois.

Ration

	Percent
Protein	9 to 15
Fat	5 to 8
Salt	0.25 to 0.45
Total Mineral (Ash)	2.0 to 4.0
Calcium	0.3 to 0.8
Phosphorus	0.3 to 0.8

(Based on an as-fed basis of 66% moisture)

Additional considerations:

Salt:	Most necessary during nursing and early kit growth.
Fat:	Cold weather, nursing and early kit growth require more; less is needed between September and October (late kit growth).
Protein:	Less is required from October to May (most growth occurs), most is required from May to October for growth of fur, lactation, and kit growth.
Phosphorous and Calcium:	The most is needed during nursing and early growth. Balance of 1:1 more important than the amount.

Avoid excesses of minerals, salt, fat, and vitamins A and D.

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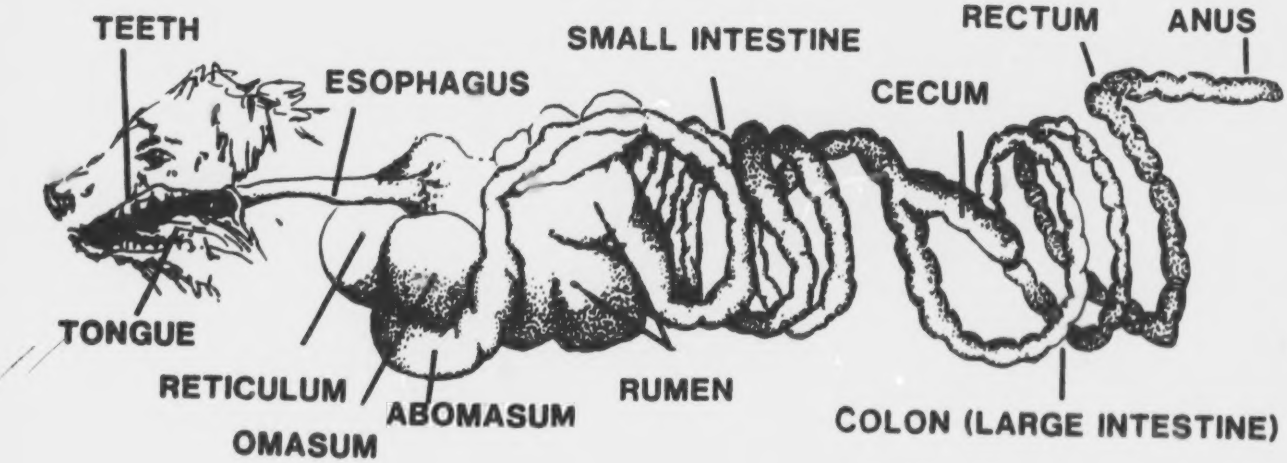
TRANSPARENCY MASTER #1

Two Types of Digestive Systems

Monogastric (nonruminant)	Polygastric (ruminant)
swine	beef cattle
horse	dairy cattle
poultry	sheep
human	goat
dog	
cat	

TRANSPARENCY MASTER #2

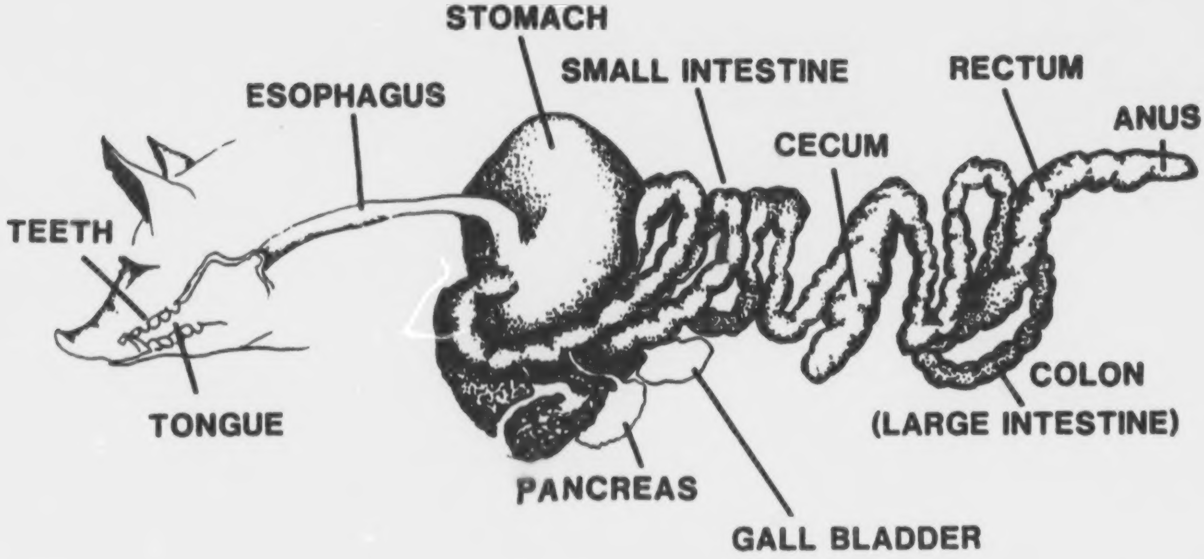
Digestive System of the Cow (ruminant)*


TEETH
ESOPHAGUS
SMALL INTESTINE
RECTUM
ANUS
CECUM
TONGUE
RETICULUM
OMASUM
ABOMASUM
RUMEN
COLON (LARGE INTESTINE)

*sheep and goats are similar

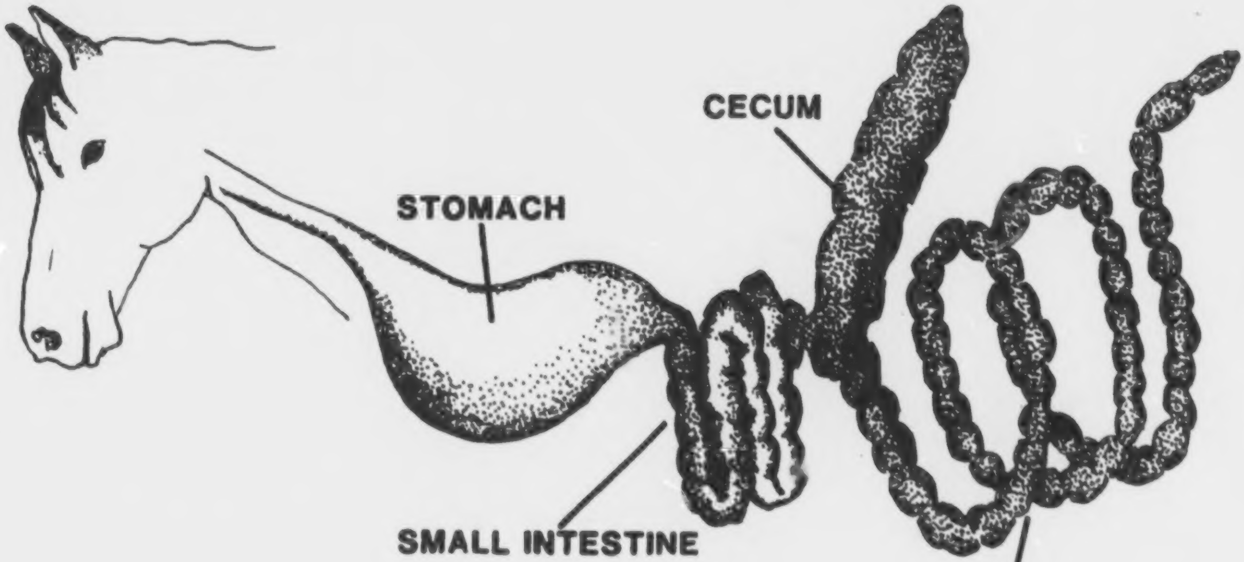
TRANSPARENCY MASTER #3

Digestive System of the Sow (nonruminant)


STOMACH
SMALL INTESTINE
RECTUM
ANUS
ESOPHAGUS
CECUM
TEETH
TONGUE
COLON
(LARGE INTESTINE)
PANCREAS
GALL BLADDER

TRANSPARENCY MASTER #4

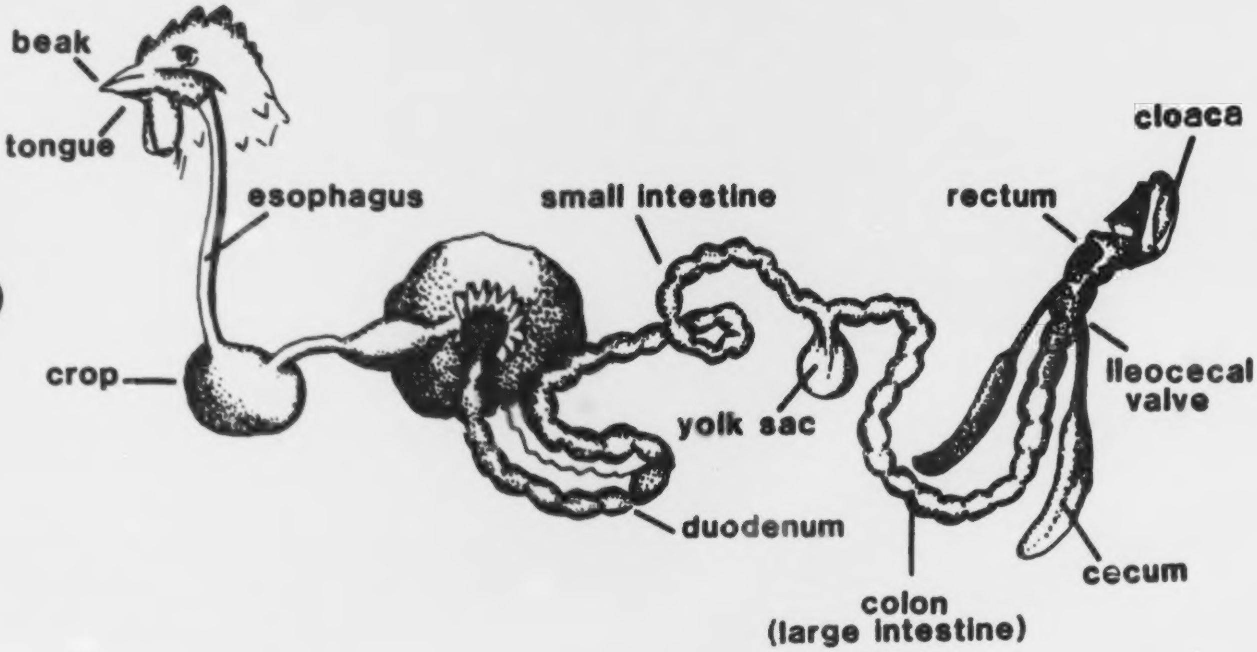
Digestive System of the Horse (nonruminant)


CECUM
STOMACH
SMALL INTESTINE
COLON (LARGE INTESTINE)

500

TRANSPARENCY MASTER #5

Digestive System of the Chicken (nonruminant)


beak
tongue
esophagus
crop
small intestine
yolk sac
duodenum
cloaca
rectum
ileocecal valve
cecum
colon
(large intestine)

507

TRANSPARENCY MASTER #6

Some Functional Differences Between Ruminants and Nonruminants

Ruminant	Nonruminant
1. Complex digestive tract	1. Simple digestive tract
2. Rumen microflora manufacture B-complex vitamins	2. Cannot manufacture B-complex vitamins
3. Utilizes low-quality protein and non-protein nitrogen	3. Cannot utilize nonprotein nitrogen
4. Digests large quantities of roughages	4. Cannot digest large quantities of roughages (except horses)
5. Can utilize a wider variety of feeds	5. Rations need to be carefully formulated

TRANSPARENCY MASTER #7

Approximate Average Capacities of Digestive Systems*

	Cattle	Swine	Horse	Sheep
Rumen	210	-	-	25
Reticulum	8	-	-	2
Omasum	20	-	-	1
Abomasum	25	8	20	4
Total Stomach	263	8	20	32
Small Intestine	70	10	70	10
Cecum	10	1	35	1
Large Intestine	30	10	100	5
Total Intestine and Cecum	110	21	205	16
Total	363	29	225	48

*capacity measured in quarts

TRANSPARENCY MASTER #8

Functions of the Rumen and Reticulum

Rumen

1. Provides storage
2. Breaks down larger particles
3. Serves as fermentation vat
   a. Approximately 75% of the digestion of dry matter in feed occurs here.
   b. Starches, sugars, cellulose, proteins, and urea are changed into volatile fatty acids (VFA), bacterial protein, and ammonia.
   c. Bacteria, protozoa, and yeasts are found here.
   d. Proteins are synthesized from nonprotein nitrogen.
   e. B-complex vitamins and vitamin K are manufactured here.

Reticulum

1. Primarily acts as a screening device
2. Regulates the flow of material from rumen to omasum
3. Assists the passage of the bolus up the esophagus
4. Collects nails, wire, and other hardware

TRANSPARENCY MASTER #9

Functions of the Omasum and Abomasum

Omasum

1. Reduces the water content of feed particles
2. Exerts a regrinding and squeezing action on feed particles

Abomasum

1. Serves as true digestive stomach
2. Secretes gastric juices containing acids and enzymes
3. Breaks down proteins
4. Passes material into the small intestine

TRANSPARENCY MASTER #10

Functions of the Duodenum, Small Intestine, Large Intestine, and Anus

Duodenum

1. Bile from the gall bladder enters here to emulsify fats.
2. The pancreas releases enzymes here to help break down proteins and carbohydrates.

Small Intestine

1. It is the major site of absorption of nutrients through villi into the bloodstream.

Large Intestine

1. It receives undigested material from the small intestine.
2. Water is conserved by reabsorption from undigested material.
3. Bacterial breakdown of undigested feed occurs here.

Anus

1. It is the passageway for feces from the large intestine to the outside of the body.

TRANSPARENCY MASTER #11

Functions of the Cecum

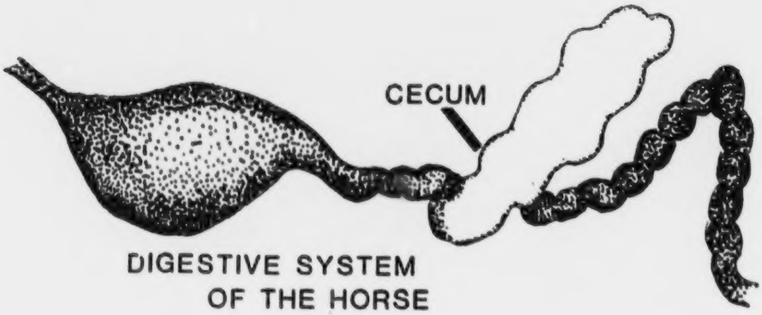
1. It is small and has limited functions in the ruminant and swine.

2. It is very important in horses and rabbits.

3. It contains microorganisms which aid in digesting roughages and fibrous materials.

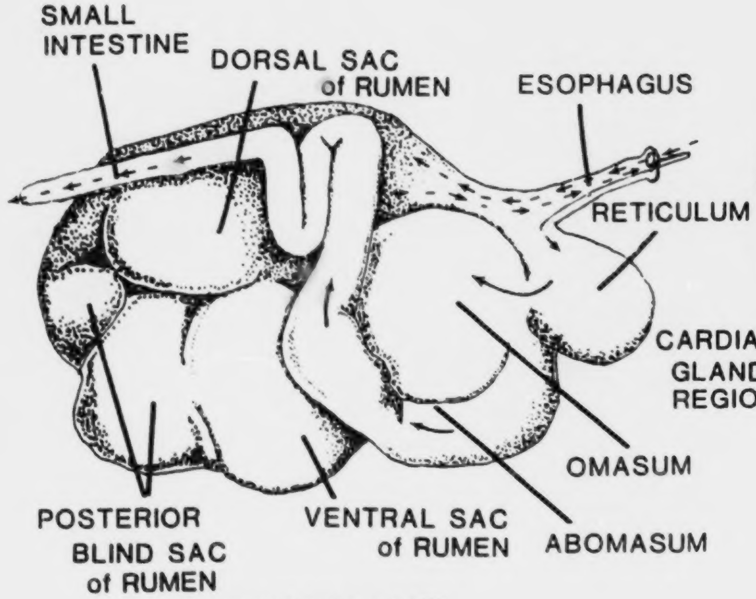
4. It serves a somewhat similar function to the rumen in ruminants.

5. It is large in the horse.

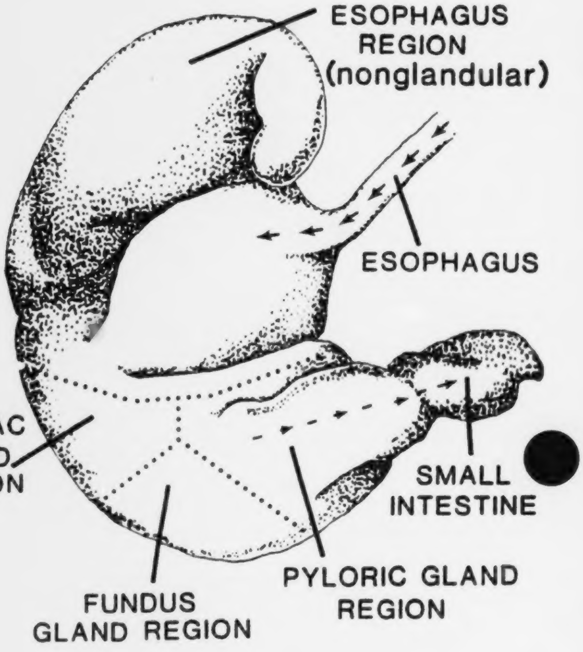


TRANSPARENCY MASTER #12

Pathway of Feed in Both Digestive Systems


SMALL INTESTINE
DORSAL SAC of RUMEN
ESOPHAGUS
RETICULUM
OMASUM
POSTERIOR BLIND SAC of RUMEN
VENTRAL SAC of RUMEN
ABOMASUM

RUMINANT


ESOPHAGUS REGION (nonglandular)
ESOPHAGUS
CARDIAC GLAND REGION
SMALL INTESTINE
FUNDUS GLAND REGION
PYLORIC GLAND REGION

NON-RUMINANT

TRANSPARENCY MASTER #13

COMPARISON OF NUTRIENT CONTENT FOR A CONCENTRATE (CORN) AND A ROUGHAGE (ALFALFA HAY)

"MOISTURE FREE"			"AIR DRY"		
DRY MATTER = 100%			DRY MATTER = 89%		DRY MATTER = 90%
No. 2 Yellow Shelled Corn		Alfalfa Hay Sun-cured (Ave. of all cuttings)	No. 2 Yellow Shelled Corn		Alfalfa Hay Sun-cured (Ave. of all cuttings)
81.7	Nitrogen Free Extract	41.0	72.7	Nitrogen Free Extract	36.9
2.3	Crude Fiber	30.2	2.0	Crude Fiber	27.2
83.9	Total Carbohydrates	71.2	74.7	Total Carbohydrates	64.1
9.9	Crude Protein	17.7	8.8	Crude Protein	15.9
4.4	Ether Extract (Fats & Oils)	2.6	3.9	Ether Extract (Fats & Oils)	2.3
1.5	Ash	9.0	1.3	Ash	8.1
Cattle – 92	TDN	Cattle – 57	Cattle – 82	TDN	Cattle – 51
Swine – 92	TDN	Swine – 36	Swine – 82	TDN	Swine – 32

How do you convert "Moisture Free" feed to an "Air Dry" basis?

TRANSPARENCY MASTER #14

Pearson Square

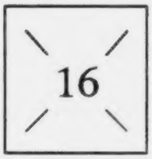
Problem:

How many pounds of *corn* and *soybean* meal should be combined to make a ton of feed for pigs weighing 35 to 75 pounds containing the appropriate *protein* allowance?

Steps to Solve Problem:

1. Determine protein allowance for growing pigs weighing 35 to 75 pounds.
2. Determine percent DP in corn and soybean meal.
3. Use the "Square Method" to determine pounds of corn and soybean meal needed.

Determine parts of each ingredient in ration:

Corn	8.8		28.0	parts corn in ration
Soybean meal	44.0		7.2	parts soybean meal
			35.2	total parts in ration

Determine % of each ingredient in ration:

28.0 ÷ 35.2 = 79.5%
7.2 ÷ 35.2 = 20.5%

Determine pounds of each ingredient in ration:

2000 x 79.5% = 1590 lbs. of corn
2000 x 20.5% = 410 lbs. soybean meal

TRANSPARENCY MASTER #15

How to Use the Square Method

The "Square Method" can be used to determine the proper proportion of two ingredients needed to provide a certain percentage of crude protein, TDN, etc.

Steps to Follow When Using the "Square Method":
Assume you want to detemine the proper amounts of shelled corn and soybean meal needed to obtain 100 pounds of a 13% CP finishing ration for swine.

- Draw a square as shown.
- Place CP% desired in center of square.
- In upper left corner, place CP% found in shelled corn. (8.8%)
- In lower left corner, place CP% found in SBM. (44.0%)
- Subtract smaller number from larger number diagonally across the square.
- Place answers in the upper and lower right corners.
- The answer on the upper right corner is the parts of shelled corn; the answer on the lower right is the parts of soybean meal.
- Add column on right to determine total parts in ration.
- Determine % corn by dividing upper right answer by the total parts; determine % SBM by dividing lower right answer by total parts.

Corn	8.8		31.0	parts corn in ration
		13		
Soybean meal	44.0		4.2	parts soybean meal
			35.2	total parts in ration

31.0 ÷ 35.2 = .88 x 100 = 88% x 100 lbs. = 88 lbs. corn

4.2 ÷ 35.2 = .119 x 100 = 12% x 100 lbs. = 12 lbs. soybean meal

TRANSPARENCY MASTER #16

Using the Square Method to Combine Several Feed Ingredients

Problem:

How many pounds of shelled corn, ground oats, soybean meal(SBM), and meat and bone scraps (M&BS) should be combined to make one ton of a sow gestation ration? Use a corn:oat ration of 3:1 and a SBM:M&BS ratio of 1:1. Assume that you will include 25 lbs. of calcium carbonate, 25 lbs. of dicalcium phosphate, 10 lbs. of salt, 5 lbs. of a vitamin-trace mineral mix, and 5 lbs. choline chloride in your one ton of feed.

Steps to Solve Problem:

1. Determine protein allowance for gestating sows.
   12% CP
2. Determine percent CP in corn and in oats.
   Corn: 8.8% Oats: 12.0%
3. Determine percent CP in SBM and in M&BS.
   SBM: 44% M&BS: 50%
4. Calculate the average CP%.

In grain mixture:		In the supplement mixture:	
3 parts corn:	8.8%	1 part SBM:	44%
	8.8	1 part M&BS:	50%
	8.8		
1 part oats:	12.0		
	38.4%		94%

38.4 ÷ 4 = 9.6% CP

94 ÷ 2 = 47% CP

5. Use the "Square Method" to determine parts of each mix.

Grain mix	9.6	$\boxed{12}$	35.0
Supplement mix	47.0		2.4
			37.4

35.0 ÷ 37.4 = 94% grain 2.4 ÷ 37.4 = 6% supplement

6. Calculate lbs. of grain and supplement needed (note: 70 lbs. of feed is already committed; the total must be 1930 lbs.).
   1930 x 94% = 1814 lbs. grain mix
   1930 lbs. x 6% = 116 lbs. supplement mix

7. Calculate lbs. of corn and lbs. of oats needed.
   Corn = 75% of 1814 lbs. = 1360 lbs.
   Oats = 25% of 1814 lbs. = 454 lbs.

8. Calculate lbs. of SBM and lbs. of M&BS needed:
   SBM = 50% of 116 lbs. = 58 lbs.
   M&BS = 50% of 116 lbs. = 58lbs.

9. List of ingredients in total ration:

Corn	1360
Oats	454
Soybean meal	58
Meat and bone scraps	58
Calcium chloride	25
Dicalcium phosphate	25
Salt	10
Vit-min mix	5
Choline chloride	5
Total	2000 lbs. = 1 ton

TRANSPARENCY MASTER DISCUSSION GUIDES

Transparency Master #1

There are two types of digestive systems found in common farm animals. Swine, horses, and poultry are known as nonruminants or monogastric animals because they have one stomach. Cattle, sheep, and goats are known as ruminants or polygastric animals because they have four sections to their stomach.

Transparency Master #2

Note the four sections to the stomach (rumen, reticulum, omasum, abomasum); also, the existence of a relatively small cecum.

Transparency Master #3

Note only one section to the stomach and the relatively small cecum.

Transparency Master #4

Note only one section to the stomach, but a large cecum. The cecum in the horse (also in the rabbit) has many functions similar to the rumen in ruminants. It allows horses to eat large quantities of forages.

Transparency Master #5

Note only one section to the stomach. Chickens have a crop where feed is stored and moistened. Feed eventually passes into the gizzard (not shown) where it is ground and crushed. It then passes into the small intestine for absorption.

Transparency Master #6

The major physical difference between the two digestive systems is the number of sections to the stomach.

Transparency Master #7

Some of the major functional differences between the two digestive systems are noted. The rumen microflora and ruminants live in a close symbiotic relationship with each other.

Transparency Master #8

The approximate average capacities of the various sections of the digestive tracts of certain species are given. Note the large difference in total stomach capacity, cecum capacity, and large intestine capacity between horses and cattle.

Transparency Master #12

A comparison of the pathway of feeds as they enter the digestive system of a ruminant and nonruminant.

Transparency Master #13

This chart compares a representative concentrate and roughages. Note the higher NFE and TDN values for the concentrate. The roughage has a higher CF and ASH content. Some feed composition tables give data on a **moisture free** basis (100% DM). It is often desirable to convert these figures to an **air dry** basis. The following formula will convert components of a moisture free feed to a given air dry basis.

% part in air dry feed = (% part in moisture free feed X % dry matter of feed on air dry basis) + % dry matter in moisture free feed
To determine % CP in 89% dry matter corn when you know the % CP in moisture free feed (i.e. 9.9%):
% CP in air dry feed = (9.9 X 89) + 100 = 8.8

Transparency Master #14

The "Square Method" is the easiest way to determine the proper amounts of a concentrate and a supplement that should be combined to produce a feed with a given percentage of crude protein. Young pigs weighing 35 to 75 pounds need a 16% CP feed. Corn contains 8.8% CP and SBM contains 44% CP. Combining 1590 pounds of corn and 410 pounds of SBM will result in a 16% CP ration.

Transparency Master #15

Following the steps shown for using the "Square Method" indicates that 88 percent of the ration should be corn and 12 percent should be SBM. Therefore, 100 pounds of feed would contain 88 pounds (100 x 88%) of corn and 12 pounds (100 x 12%) of SBM.

Transparency Master #16

The "Square Method" may be used to determine the amounts of several ingredients that should be combined to obtain a final ration containing a specified CP percentage. Remember that 70 lbs. of the 2,000 lbs. in a ton of feed are already committed to other ingredients. Consequently, the grain and supplement combined can only total 1930 lbs.

STUDENT ACTIVITIES

STUDENT WORKSHEET #1 — Digestion in Animals

STUDENT WORKSHEET #2 — General Facts on Livestock Feeding

STUDENT WORKSHEET #3 — Balancing a Ration

STUDENT WORKSHEET #4 — Computing Feed Rations

STUDENT WORKSHEET #5 — Feeding the Beef Cow Herd

STUDENT WORKSHEET #6 — Feeding Swine and Sheep

For additional activities, teachers may refer to the "Suggested Teaching Activities and Procedures" section in the Instructor's Guide.

STUDENT WORKSHEET #1

Digestion in Animals

1. Define Digestion ____

____

2. The tubelike passage from the mouth to the stomach is called the ______________.

3. The four divisions of the ruminant stomach are:

    a. ______________ c. ______________

    b. ______________ d. ______________

4. The part of the digestive system where most digestion is completed and most absorption takes place is the ______________.

5. How can the horse digest roughage since it has a simple stomach? ______________________

____

____

6. The ______________ produces bile and is the largest gland in the body.

7. What is the first step in digestion? ______________________

____

____

8. Discuss how digestion in the stomach of a ruminant is different than digestion in a nonruminant.

____

____

____

9. What three digestive juices are mixed with the "Chyme" when in the small intestine?

    a. ______________

    b. ______________

    c. ______________

10. Describe how the digested foodstuff is absorbed by the small intestine.

____

____

____

____

____

STUDENT WORKSHEET #1 — Key

Digestion in Animals

1. Define Digestion *See Information Sheet #3.*

2. The tubelike passage from the mouth to the stomach is called the *esophagus*.

3. The four divisions of the ruminant stomach are:
   a. *rumen*
   b. *reticulum*
   c. *omasum*
   d. *abomasum*

4. The part of the digestive system where most digestion is completed and most absorption takes place is the *small intestine*.

5. How can the horse digest roughage since it has a simple stomach? *Active and large caecum digests the roughage; acts similar to the rumen.*

6. The *liver* produces bile and is the largest gland in the body.

7. What is the first step in digestion? *Breaking, cutting, and tearing up of food*

8. Discuss how digestion in the stomach of a ruminant is different than digestion in a nonruminant. *Refer to VAS 1026A, part 3.*

9. What three digestive juices are mixed with the "Chyme" when in the small intestine?
   a. *pancreatic juice*
   b. *bile*
   c. *intestinal juice*

10. Describe how the digested foodstuff is absorbed by the small intestine. *Refer to VAS 1026A, part 6.*

STUDENT WORKSHEET #2

General Facts on Livestock Feeding

1. Why do animals need nutrients? ______________________________
____
____

2. List and give the functions of the six classes of nutrients.

   a. ______________________________
   b. ______________________________
   c. ______________________________
   d. ______________________________
   e. ______________________________
   f. ______________________________

3. What is the difference between a "good ration" and a "balanced ration"? ______________
____
____
____

4. Briefly state the "rules-of-thumb" to use when formulating rations for:

   a. Beef Cattle — ______________________________
   b. Dairy Cattle — ______________________________
   c. Swine — ______________________________
   d. Sheep — ______________________________
   e. Poultry — ______________________________

5. List some recommended practices in providing water for livestock. ______________
____
____

6. Feed costs make up about ________ percent of the total cost of producing an animal.

524

STUDENT WORKSHEET #2 — Key

General Facts on Livestock Feeding

1. Why do animals need nutrients? *Maintenance, growth, finishing, production, reproduction*

2. List and give the functions of the six classes of nutrients. *Refer to VAS transparency "Sources of Energy"*

   a. *Carbohydrates*
   b. *Proteins*
   c. *Fats*
   d. *Minerals*
   e. *Vitamins*
   f. *Water*

3. What is the difference between a "good ration" and a "balanced ration"? *Refer to VAS 1013A, part 2.*

4. Briefly state the "rules-of-thumb" to use when formulating rations for: *Refer to VAS 1013A, part 3.*

   a. Beef Cattle —
   b. Dairy Cattle —
   c. Swine —
   d. Sheep —
   e. Poultry —

5. List some recommended practices in providing water for livestock. *Clean and adequate supply*

6. Feed costs make up about 70 percent of the total cost of producing an animal.

STUDENT WORKSHEET #3

Balancing a Ration

1. Obtain a copy of a standard feedstuff composition table and answer the following:

   a. Fill in the fiber content for these feedstuffs:

      100 lbs. corncobs, ground _______%_______lbs.
      100 lbs. timothy hay, fullbloom _______%_______lbs.
      56 lbs. corn, dent #2 _______%_______lbs.
      50 lbs. fishmeal, all analysis _______%_______lbs.
      50 lbs. soybean meal, solvent process _______% _______lbs.

   b. Fill in the protein content:

	Total protein%	Digestible Protein%
34 lbs. oats, usual grade	___________	___________
56 lbs. corn, dent #2	___________	___________
50 lbs. soybean meal, solvent	___________	___________
100 lbs. timothy hay, fullbloom	___________	___________
100 lbs. corncobs, ground	___________	___________

2. Balance the following rations using the Pearson Square Method. Show % of each foodstuff and amount per ton.

   a. 20% ration using corn 8% crude protein and soybean meal 45% crude protein.

   b. 10% ration using grain sorghum 7% crude protein and bloodmeal 80% crude protein.

   c. 15% ration using equal parts of corn 7% and wheat 9% crude protein, and equal parts of soybean meal 45% and fishmeal 65% crude protein.

STUDENT WORKSHEET #3 — Key

Balancing a Ration*

1. Obtain a copy of a standard feedstuff composition table and answer the following:

   a. Fill in the fiber content for these feedstuffs:

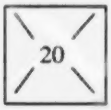
      100 lbs. corncobs, ground 32 % 32 lbs
      100 lbs. timothy hay, fullbloom 30.3 % 30.3 lbs.
      56 lbs. corn, dent #2 2.2 % 1.23 lbs.
      50 lbs. fishmeal, all analysis 0.9 % 0.45 lbs.
      50 lbs. soybean meal, solvent process 5.9 % 2.95 lbs.

   b. Fill in the protein content:

	Total protein%	Digestible Protein%
34 lbs. oats, usual grade	5.5	4.0
56 lbs. corn, dent #2	9.5	7.1
50 lbs. soybean meal, solvent	46.4	39.4
100 lbs. timothy hay, fullbloom	6.2	3.2
100 lbs. corncobs, ground	2.3	0.4

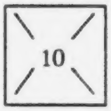
2. Balance the following rations using the Pearson Square Method. Show % of each foodstuff and amount per ton.

   a. 20% ration using corn 8% crude protein and soybean meal 45% crude protein.



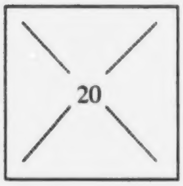
	Parts	%	lbs.
corn 8%	25	67.5	1350
SBM 45%	12	32.5	650
	37	100.0%	2000

   b. 10% ration using grain sorghum 7% crude protein and bloodmeal 80% crude protein.



	Parts	%	lbs.
GS 7%	70	96.0	1920
BM 80%	3	4.0	80
	73	100.0%	2000

   c. 15% ration using equal parts of corn 7% and wheat 9% crude protein, and equal parts of soybean meal 45% and fishmeal 65% crude protein.



		Parts	Parts	%	lbs.
corn 7% wheat 9%	8%	40	20 corn	42.5	850
			20 wheat	42.5	850
			3.5 SM	7.5	150
SM 45% FM 65%	55%	7	3.5 FM	7.5	150
		47	47	100.0%	2000

*Answers will vary depending on information source.

STUDENT WORKSHEET #4

Computing Feed Rations

Problem:

A farmer needs to formulate an efficient feed ration, using the grains commonly and readily available. Make up a low-cost feed mixture for the farmer and use the list of feeds as suggested by your instructor. Prices can be obtained from the local feed store or in the latest Voc. Ag. Service *News and Notes.*

1. The farmer needs you to compute a ration for:

2. The farmer has the following feeds available:

RATION

	Feed (lbs)	Total Dry Matter (lbs)	Digestible Protien (lbs)	Total Digestible Nutrients (lbs)	(Other)	Cost
Requirements (Range)						
Total						

52S

STUDENT WORKSHEET #4 — Key

Computing Feed Rations

Problem:

A farmer needs to formulate an efficient feed ration, using the grains commonly and readily available. Make up a low-cost feed mixture for the farmer and use the list of feeds as suggested by your instructor. Prices can be obtained from the local feed store or in the latest Voc. Ag. Service *News and Notes.*

1. The farmer needs you to compute a ration for:
   A number of 425 lb. feeder steers.

2. The farmer has the following feeds available:
   Corn, and alfalfa hay

RATION

	Feed (lbs)	Total Dry Matter (lbs)	Digestible Protien (lbs)	Total Digestible Nutrients (lbs)	Cost
Requirements (Range)	12+	14.8 - 17.5	1.39 - 1.52	11.6 - 13.2	—
Corn, #2 dent	*4.0*	*3.40*	*.27*	*3.20*	*$0.08*
Corn Silage	*10.5*	*2.90*	*.13*	*1.92*	*$0.05*
Alfalfa hay	*8.0*	*7.24*	*.87*	*4.06*	*$0.08*
Oats, Not PC	*2.0*	*1.80*	*.19*	*1.40*	*$0.05*
Dried Beet Pulp	*1.5*	*1.37*	*.06*	*1.03*	*$0.07*
Total	*26.0*	*16.71*	*1.52*	*11.61*	*$0.33*

STUDENT WORKSHEET #5

Feeding the Beef Cow Herd

(**NOTE:** References — Animal Nutrition Transparencies and back page of Illinois Production Record Book)

1. Name six functions of minerals in an animal's diet.

   a. ______________________
   b. ______________________
   c. ______________________
   d. ______________________
   e. ______________________
   f. ______________________

2. Identify the *major* and *trace* minerals.

Major	Trace

3. Complete the following chart. Identify four fat-soluble vitamins and five water-soluble vitamins, and give their function, deficiency symptoms, and source.

   a. Fat-soluble vitamins

Vitamin	Function	Deficiency Symptom	Source

   b. Water-soluble Vitamins

Vitamin	Function	Deficiency Symptom	Source

4. Complete the chart for female beef, swine, and sheep. (Note: for reference, refer to back cover of production record book.)

Class	Recommended Age for Breeding (months)	Recommended size for Breeding	Duration of Heat Period	Length of Gestation Days
Beef				
Swine				
Sheep				

5. Define a "pasture day."

6. Identify the number of head included in "one animal unit" for the following:

   a. Mature cow or bull ______________
   b. Yearling cattle ______________
   c. Feeder cattle (lbs) ______________
   d. Weaned calves ______________
   e. Pigs ______________
   f. Mature sheep ______________
   g. Weaned lambs ______________

7. Calculate the pasture growing days for your area by using the average date of last freeze in spring and the first freeze in the fall.

8. Calculate the animal units and then, assuming they were on pasture for 90 days, calculate the pasture days for:

	Units	PD
a. 50 cows, 2 bulls, 45 yearling cattle, and 42 weaned calves	________	________
b. 150 pigs	________	________
c. 40 ewes, 3 rams, and 50 weaned lambs	________	________

STUDENT WORKSHEET #5 — Key

Feeding the Beef Cow Herd

(**NOTE:** References — Animal Nutrition Transparencies and back page of Illinois Production Record Book)

1. Name six functions of minerals in an animal's diet.

   a. *Give strength and rigidity to bones and teeth*
   b. *Necessary for building body tissue*
   c. *Aid in regulation of body processes*
   d. *Aid in digestion of food*
   e. *Interact with vitamins*
   f. *Influence oxygen-carrying capacity of blood*

2. Identify the *major* and *trace* minerals.

Major	Trace
Sodium	*Chromium*
Chlorine	*Cobalt*
Calcium	*Copper*
Phosphorus	*Fluorine*
Magnesium	*Iodine*
Potassium	*Iron*
Sulfur	*Manganese*
	Molybdenum
	Selenium
	Silicon
	Zinc

3. Complete the following chart. Identify four fat-soluble vitamins and five water-soluble vitamins, and give their function, deficiency symptoms, and source.

   a. Fat-soluble vitamins

Vitamin	Function	Deficiency Symptom	Source
A	*Night vision*	*Night blindness*	*Green leafy hays, pasture, corn*
D	*Bone & teeth development*	*Rickets*	*Direct sunlight, sun-cured hay*
E	*Cell maintenance*	*Reproductive problems*	*Green plants, green hay*
K	*Blood clotting*	*Hemorrhaging*	*Green pasture, good quality hay*

   b. Water-soluble Vitamins

Vitamin	Function	Deficiency Symptom	Source
B_1	*Energy metabolism*	*Reduction in appetite*	*Cereal grains, green pastures, good quality hay*
B_2	*Energy metabolism*	*Slow growth*	*Green pastures, good quality hay*
B_{12}	*Enzyme*	*Reproductive failure*	*Tankage, fish meal*
Biotin	*Enzyme system*	*Skin problems*	*Milk and synthetic biotin*
C	*Resistance to infection*	*Loose teeth, weak bones*	*Green pasture and citrus fruit*

4. Complete the chart for female beef, swine, and sheep. (Note: for reference, refer to back cover of production record book.)

Class	Recommended Age for Breeding (months)	Recommended size for Breeding	Duration of Heat Period	Length of Gestation Days
Beef	*15-24*	*650-750 lbs.*	*3-48 hours*	*283*
Swine	*8-10*	*180-200 lbs.*	*1-3 days*	*114*
Sheep	*18-20*	*110-130 lbs.*	*1-3 days*	*150*

5. Define a "pasture day."

Amount of pasture eaten in one day by one animal unit

6. Identify the number of head included in "one animal unit" for the following:

a. Mature cow or bull	*1*
b. Yearling cattle	*1 1/2*
c. Feeder cattle (lbs)	*1,000 lbs.*
d. Weaned calves	*2*
e. Pigs	*15*
f. Mature sheep	*5*
g. Weaned lambs	*10*

7. Calculate the pasture growing days for your area by using the average date of last freeze in spring and the first freeze in the fall.

Answers will vary with area

8. Calculate the animal units and then, assuming they were on pasture for 90 days, calculate the pasture days for:

	Units	PD
a. 50 cows, 2 bulls, 45 yearling cattle, and 42 weaned calves	*103*	*9,270*
b. 150 pigs	*10*	*900*
c. 40 ewes, 3 rams, and 50 weaned lambs	*48*	*4,320*

STUDENT WORKSHEET #6

Feeding Swine and Sheep

(**NOTE:** Reference for questions 1 to 7: VAS Unit 1036A)

1. Identify four requirements of swine which should be considered when planning a feed ration.

   a.
   b.
   c.
   d.

2. Why do hogs not thrive well on corn alone?

3. Name six cereal grains which can be used in a hog's ration, and identify some advantages and disadvantages for each grain.

   a.
   b.
   c.
   d.
   e.
   f.

4. Identify four feeds used locally as protein sources for swine.

   a.
   b.
   c.
   d.

5. How do local swine producers develop rations which are balanced for minerals and vitamins?

6. What are antibiotics, and why are they added to swine rations?

7. Identify forage crops which are used locally by swine producers and give some advantages and disadvantages of these crops.

(NOTE: Reference for questions 8 to 11: VAS Unit 1060)

8. What concentrate mixtures are commonly used in the local community for ewe flocks?

9. Identify six problems which could result from a ewe having inadequate nutrition during pregnancy.

   a.
   b.
   c.
   d.
   e.
   f.

10. Why has self-feeding of pregnant ewes been increasing?

11. What should be the crude protein content for the following rations:

    a. Creep ration —

    b. Early-weaned ration —

    c. Young lambs —

    d. Market lambs —

STUDENT WORKSHEET #6 — Key

Feeding Swine and Sheep

(NOTE: Reference for questions 1 to 7: VAS Unit 1036A)

1. Identify four requirements of swine which should be considered when planning a feed ration.

   a. *Maintenance*
   b. *Growth*
   c. *Fattening*
   d. *Production and reproduction*

2. Why do hogs not thrive well on corn alone?

   Refer to Part 1a, VAS 1036A.

3. Name six cereal grains which can be used in a hog's ration and identify some advantages and disadvantages for each grain.

   a. *Corn*
   b. *Oats*
   c. *Wheat* *Refer to Part 1a for advantages and disadvantages.*
   d. *Barley*
   e. *Grain sorghum*
   f. *Rye*

4. Identify four feeds used locally as protein sources for swine.

   a
   b. *Answer through class discussion.*
   c.
   d.

5. How do local swine producers develop rations which are balanced for minerals and vitamins?

   Answer through class discussion.

6. What are antibiotics and why are they added to swine rations?

   Refer to Part 1e, VAS Unit 1036A.

7. Identify forage crops which are used locally by swine producers and give some advantages and disadvantages of these crops.

   Answer through class discussion.

(**NOTE:** Reference for questions 8 to 11: VAS Unit 1060)

8. What concentrate mixtures are commonly used in the local community for ewe flocks?

   Answer through class discussion.

9. Identify six problems which could result from a ewe having inadequate nutrition during pregnancy.

   a. *A higher percentage of ewes with pregnancy disease*
   b. *A decrease in birth weights*
   c. *Weaker lambs at birth*
   d. *An increase in infant lamb mortality*
   e. *Lambs slower in gaining weight*
   f. *Lower milk yields during lactation*

10. Why has self-feeding of pregnant ewes been increasing?

    Refer to VAS Unit 1060, part 2.

11. What should be the crude protein content for the following rations:

    Refer to VAS Unit 1060, parts 6 and 7.

    a. Creep ration —

    b. Early-weaned ration —

    c. Young lambs —

    d. Market lambs —

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Understanding Animal Breeding and Reproduction

RELATED PROBLEM AREAS:

1. Identifying Basic Principles of Animal Science (Central Core Cluster)
2. Understanding Animal Anatomy and Physiology
3. Maintaining Animal Health
4. Meeting Environmental Requirements of Animals
5. Recognizing the Impact of Technology on Agriculture: Biotechnology (Central Core Cluster)
6. Raising Game Birds and Animals (Agricultural Resources Cluster)

PREREQUISITE PROBLEM AREA(S):

1. Understanding Basic Genetics and Reproduction (Central Core Cluster)

LEVEL: Preparatory

OCCUPATIONAL TASKS ADDRESSED:

Agricultural Business and Management Cluster

Duty A: Formulating Livestock Feeding Programs

1. Assessing livestock needs, such as growing and fattening, nursing, production, or specific nutritional needs

Duty D: Marketing Animals and Animal Products

1. Plan marketing schedule

Duty H: Managing the Business

1. Evaluate agribusiness productivity
2. Maintain production records
3. Maintain animal records

Duty I: Assembling, Servicing, and Maintaining Equipment and Facilities

1. Maintain hand tools
2. Clean various surfaces
3. Disinfect pens, cages, and runs
4. Sterilize injection equipment

Duty N: Breeding, Handling and Caring for Animals

1. Inseminate animals artificially
2. Pregnancy test animals
3. Assist animals in delivery
4. Assist young to nurse
5. Castrate animals

Duty P: Maintaining Animal Health

1. Disinfect buildings and equipment

Duty S: Performing Examining Room and Lab Work

1. Collect semen

STATE GOALS FOR LEARNING

In planning the instruction for this problem area, teachers can promote the development of several student learning objectives which are related to the State Goals for Learning in Biological and Physical Sciences. These objectives are listed on the Learning Assessment Plan forms included on the following page(s). Those learning objectives marked with an asterisk (*) are taken from the sample lists provided by the Illinois State Board of Education.

CORE

Illinois Agricultural Core Curriculum

Agricultural Education 124 Mumford Hall 1301 W. Gregory Drive University of Illinois Urbana, IL 61801

Director: Dale A. Law, Ed.D.
Principal Investigator: Jerry D. Pepple, Ed.D.
Research Assistant: Robert E. Petrea

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date ____________________

☐ Original submission ☐ Revision

Page _____ of _____

I. LEARNING AREA *(check one)*

☐ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☒ Sciences ☐ Physical Development/Health

(Affix label or complete district information.)

COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐

District Name

City

Contact Person: ____________________

Title: ____________________

Phone: (   )

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will have a working knowledge of the concepts and basic vocabulary of biological, physical, and environmental sciences and their application to life and work in contemporary technological society.

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Understand that complex animals carry out vital processes within organ systems which are separate in function but actually dependent.					
*2. Recognize basic animal systems from preserved specimens.					
*3. Identify body changes and explain how hormones cause some of these body changes.					
*4. Identify major organs of the body and relate them to a function.					
5. Define terms integral to animal breeding and reproduction.					
6. Describe the types of breeding systems available.					
7. Differentiate between natural and artificial systems of mating and discuss the merits of each.					
8. Identify the parts of the male reproductive system and describe their function.					
9. Identify the parts of the female reproductive system and describe their function.					
10. Summarize the reproductive cycle and describe the specific cycle of individual species.					541

Understanding Animal Breeding and Reproduction

Agricultural Business and Management
Animal Science

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date ____________

☐ **Original submission** ☐ **Revision**

Page ____ of ____

I. LEARNING AREA *(check one)*

☐ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☒ Sciences ☐ Physical Development/Health

(Affix label or complete district information.)

COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐

District Name

City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will have a working knowledge of social and environmental implications of technological development.

Contact Person: ____________

Title: ____________

Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Understand the impact of technological developments on society.					
*2. Recognize the implications of modern genetic technology.					
3. Give examples of recent technological advances in reproduction and discuss implications related to their use.					
548					
					548

Illinois Agricultural Core Curriculum Rev.

Submission Date ____________________

☐ Original submission ☐ Revision

Page _____ of _____

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)

COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐

District Name

City

I. LEARNING AREA *(check one)*

☐ Language Arts
☐ Mathematics
☒ Sciences
☐ Fine Arts
☐ Social Sciences
☐ Physical Development/Health

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will have a working knowledge of principles of scientific research and their application in simple research projects.

Contact Person: ____________________

Title: ____________________

Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Demonstrate the ability to draw conclusions from collected data.					

Understanding Animal Breeding and Reproduction

Agricultural Business and Management
Animal Science

ISBE 41-78 (1/88)

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Understanding Animal Breeding and Reproduction

STUDENT LEARNING OBJECTIVES

Upon completion of their study of this problem area, students will be able to:

1. Define terms integral to animal breeding and reproduction.
2. Describe the types of breeding systems available.
3. Differentiate between natural and artificial systems of mating and discuss the merits of each.
4. Identify the parts of the male reproductive system and describe their function.
5. Identify the parts of the female reproductive system and describe their function.
6. Summarize the reproductive cycle and describe the specific cycle of individual species.
7. Give examples of recent technological advances in reproduction and discuss implications related to their use.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Understanding Animal Breeding and Reproduction

PROBLEMS AND QUESTIONS FOR STUDY

INSTRUCTOR'S NOTES AND REFERENCES

1. What is reproduction?
2. What is breeding?
3. How is natural breeding different from artificial breeding?
4. What are the different types of natural breeding? Artificial breeding?
5. What is meant by breeding systems?
6. What are the different types of crosses in breeding?
7. What are the parts of the male reproductive system? How do these parts function?
8. What are the parts of the female reproductive system? How do these parts function?
9. How do the reproductive systems of animals differ?
10. What is the reproductive cycle?
11. How are the reproductive cycles of animals similar? Different?
12. What techniques are used in artificial insemination?
13. What technology is necessary for successful artificial insemination?
14. What is embryo transfer? Heat synchronization? Gene splitting? Cloning?
15. How do these new technologies affect the producer? The consumer? The general public?
16. What advantages and disadvantages can be proposed for these new technologies?

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Understanding Animal Breeding and Reproduction

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES

1. Use life science personnel as resource persons for materials, equipment, models, and ideas.

2. Use the transparencies provided along with slides, models and preserved specimens for enhanced student application of information.

3. Use local producers, artificial insemination technicians, and local veterinarians as resource persons for class demonstrations.

4. Plan field trips to local production facilities, veterinary offices, or breeding services to observe collection of semen, freezing of semen, artificial insemination, heat synchronization, and embryo transfers.

5. Use VAS Unit #U1002c, *Artificially Inseminating Livestock*, as a student resource for study.

6. Secure and use copies of Instructional Material Service Subject Matter Unit #8407, *Methods of Animal Breeding*, and Subject Matter Unit #8405, *Animal Reproduction*, for use as students resources for study.

7. Secure and use a copy of the filmstrips, *Artificial Insemination of Beef and Dairy Cattle* and *Embryo Transfer of Beef and Dairy Cattle*, for enhanced student application of information. These can be obtained from California Polytechnic State University.

8. Use problem area, *Recognizing the Impact of Technology on Agriculture: Biotechnology*, as a resource for information on gender selection and gene splitting.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Understanding Animal Breeding and Reproduction

REFERENCES

INSTRUCTOR'S NOTES AND REFERENCES

*1. *Embryo Transfer of Beef and Dairy Cattle* (#1-413-231H); *Artificial Insemination of Beef and Dairy Cattle* (#1-413-232H). Vocational Education Production, California Polytechnic State University, San Luis Obispo, CA 93407. (800) 235-4146.

*2. *Artificially Inseminating Livestock* (VAS Unit #U1002c); *Animal Genetics and Breeding* (VAS Transparency Set #T130). Vocational Agriculture Service, College of Agriculture, University of Illinois, 1401 S. Maryland Drive, Urbana, IL 61801. (217) 333-3871.

3. *Anatomy and Physiology of Farm Animals.* (1974). Frandson, R.S. Lea and Febiger, West Washington Square, Philadelphia, PA 19106.

*4. *Animal Reproduction* (Subject Matter Unit #8405); *Methods of Animal Breeding* (Subject Matter Unit #8407). Instructional Materials Service, Texas A & M University, P.O. Box 2588, College Station, TX 77843. (409) 845-6601.

5. "Experiments, Demonstrations, and Laboratory Activities for Illustrating Science Applications in Agriculture." In *Agriscience Teacher Inservice Program.* Osborne, Edward W., Project Director, October 1988-January 1989. Agricultural Education, 124 Mumford Hall, 1301 W. Gregory, Urbana, IL 61801. (217) 333-3166.

*Indicates highly recommended reference

INSTRUCTIONAL RESOURCES

These resources are intended for use by teachers in planning and teaching the materials for this problem area and may be adapted to fit the teaching method(s) used.

INFORMATION SHEET #1 — Terms to be Defined

INFORMATION SHEET #2 — Embryo Transfer

INFORMATION SHEET #3 — Artificial Insemination of Cattle and Hogs

TRANSPARENCY MASTER #1 — Systems of Breeding (with discussion guide)

TRANSPARENCY MASTER #2 — Cross Breeding (Crisscross Method) (with discussion guide)

TRANSPARENCY MASTER #3 — Cross Breeding (Three-Breed Rotational Cross Method) (with discussion guide)

TRANSPARENCY MASTER #4 — Amount of Inbreeding From Various Matings (with discussion guide)

TRANSPARENCY MASTER #5 — The Reproduction Cycle in Farm Animals

TRANSPARENCY MASTER #6 — Estrous Cycle (with discussion guide)

TRANSPARENCY MASTER #7 — Time of Breeding and Conception Rate in Cattle

TRANSPARENCY MASTER #8 — Female Reproductive System (with discussion guide)

TRANSPARENCY MASTER #9 — Comparison of Female Systems (with discussion guide)

TRANSPARENCY MASTER #10 — Uteri of Farm Animals (with discussion guide)

TRANSPARENCY MASTER #11 — Female Reproductive Tract (top view) (with discussion guide)

TRANSPARENCY MASTER #12 — Ovulation (with discussion guide)

TRANSPARENCY MASTER #13 — Composite Mammalian Ovary (with discussion guide)

TRANSPARENCY MASTER #14 — Male Reproductive System (with discussion guide)

TRANSPARENCY MASTER #15 — Comparison of Male Systems (with discussion guide)

TRANSPARENCY MASTER #16 — Fertilization in Cattle (with discussion guide)

TRANSPARENCY MASTER #17 — Artificial Insemination (with discussion guide)

TRANSPARENCY MASTER #18 — Why Breed Artificially

TRANSPARENCY MASTER #19 — Limitations of Artificially Inseminated

TRANSPARENCY MASTER #20 — Good Semen

TRANSPARENCY MASTER #21 — Questionable Semen

TRANSPARENCY MASTER #22 — Poor Semen

INFORMATION SHEET #1

Terms to be Defined

Afterbirth — part of the placenta that is expelled from the body after the birth of offspring.

Amniocentesis — technique in which some of the amniotic fluid surrounding an embryo is removed for analysis.

Amnion — fluid-filled sac surrounding the embryo; protects the embryo and keeps it moist.

Anestrous — condition of a female when she is without estrous cycle.

Artificial selection — procedure in which humans choose organisms to breed that have desirable features.

Chorion — thin membrane inside the shell of a land egg that functions in gas exchange; a membrane in mammals contributing to the formation of the placenta.

Conception — becoming pregnant.

Copulation — the physical procedure of natural mating between a male and female of the same species.

Egg — female productive cell; ovum.

Embryo — a developing plant or animal after fertilization; generally still contained within the egg, seed, or uterus.

Ejaculation — discharge of sperm from the penis.

Endoderm — inner tissue layer in an embryo or mature animal.

Estrogen — female sex hormone.

Estrous — entire series of chemical and physical changes leading up to the production of mature eggs.

Estrus — the period of time when a female is receptive to the male.

External fertilization — fertilization in animals in which egg is fertilized outside the female's body.

Fallopian tube — oviduct.

Fetus — a human embryo that is at least eight weeks old; any vertebrate embryo in egg or uterus.

First filial generation — first offspring produced from a parental cross.

Follicle — cell nest within an ovary; site of egg development.

Follicle stage — stage in the menstrual cycle during which an egg matures and the preparation of the uterus for a possible pregnancy begins.

Follicle-stimulating hormone (FSH) — hormone that stimulates the ripening of eggs within the follicle of the ovary; hormone that stimulates sperm production in males.

Fraternal twins — twins that develop when two different eggs are fertilized.

Gametes — sex cells; sperm and eggs.

Heterosis — vigor or capacity of growth often shown by crossbred animals.

Identical twins — twins that have the same genotypes, resulting from the splitting of a zygote into two separate parts.

Internal fertilization — process in animals in which sperm is deposited inside the female reproductive organs where fertilization occurs.

Luteinizing hormone (LH) — hormone that causes the follicle to rupture and the ruptured follicle to change to the corpus luteum; causes production of testosterone in males.

Menstrual — monthly series of hormonal changes leading to egg maturation and uterine preparation for a possible pregnancy.

Menstruation — stage of the menstrual cycle usually lasting from three to five days during which blood, some uterine tissue, and the unfertilized egg are expelled from the vagina.

Mouthbreeder — an animal that picks up and holds the fertilized eggs in its mouth until the eggs hatch.

Ovary — swollen lower region of the pistil in flowering plants; female gonad in animals; where eggs are produced.

Oviduct — tube close to each ovary in the mammalian female; conveys the egg from ovary to uterus; fallopian tube.

Ovulation — short stage in the menstrual cycle in which the follicle bursts and the mature egg is released.

Ovum — egg.

Parental cross — mating of two organisms to produce offspring; usually refers to first mating in a series.

Parturition — process of giving birth.

Penis — male reproductive organ in animals that have internal fertilization.

Placenta — mass of small blood vessels and associated tissues across which materials are exchanged between embryo and mother.

Progesterone — hormone secreted by the corpus luteum; maintains the uterus in its prepared condition for pregnancy.

Puberty — onset of the development of secondary sexual characteristics.

Progeny — offspring of animals.

Reproduction — process in which new organisms are produced.

Scrotum — external sac that encloses the testes of a mammal.

Second filial generation — generation of offspring produced from interbreeding offspring of the first filial generation.

Semen — combination of sperm and fluid.

Sexual reproduction — union of two sets of DNA; fusion process.

Siblings — brothers or sisters.

Sperm — male reproductive cell.

Sperm duct — area in the male reproductive system where fluids are added to the sperm.

Standing heat — period during estrus when a female will stand and accept a male.

Sterility — inability to reproduce.

Testis — male gonad.

Testosterone — androgen that stimulates the formation of secondary sexual characteristics in males.

Vagina — the organ in the female that receives sperm from the male.

Yolk sac — structure in the shelled egg that contains yolk, the food source for the developing embryo.

INFORMATION SHEET #2

Embryo Transfer

Embryo transfer refers to the process of removing an embryo in its early development from the female's reproductive tract and transferring it to another female's reproductive tract for development and subsequent birth. This is an expensive and labor-intensive procedure that is used more in cattle than in any other species of livestock. However, through use of artificial insemination and embryo transfer, there can be a larger number of offspring from genetically superior sires and dams.

Basically, the female is superovulated with a special hormonal injection (Follicle Stimulating Hormone). This causes the ovary to produce multiple eggs (ova) which will ovulate and enter the female's reproductive tract. The female is then bred either by natural or artificial means several times to insure fertility. The young embryos are then removed from the female approximately 6-11 days post estrus. They are removed either surgically or, more commonly, through the use of a specialized catheter called a Foley Catheter.

Through the use of an estrous synchronization program, there should be several females prepared to receive an embryo from the donor female. The receiving females must be in the same stage of the estrous cycle for the embryo to be accepted by the reproductive tract. If the pregnancies prove successful, there should be several siblings born at approximately the same time from different females.

INFORMATION SHEET #3

Artificial Insemination of Cattle and Hogs

Instructor review and suggestions for laboratory activity.

1. Objectives and Background Information

Artificial insemination is the placement of spermatozoa of the male into the female reproductive tract by artificial means. In contrast, natural insemination occurs when the male deposits spermatozoa in the female tract during copulation.

Artificial insemination was first used worldwide in the dairy industry and is now an accepted practice of beef and dairy cattle producers. Artificial insemination is possible in nearly all species of farm animals.

This exercise is designed to introduce students to the scientific advances that have been made in animal reproduction using artificial insemination. They will learn the phases of the estrous cycle and the proper time for breeding, the anatomy of the reproductive systems of cattle and hogs, and the insemination technique used in both. In addition, gestation lengths, length of the estrous cycle and hormonal controls will be discussed.

The equipment that has been developed and is currently being used for artificial insemination will be available for inspection. Techniques of artificial insemination will be demonstrated.

2. Materials Needed

Materials needed are reproductive tracts from cows/heifers and sows/gilts, semen from boars and bull, insemination equipment, microscope, slides, test tubes, and styrofoam cups.

Reproductive tracts may be obtained from your local locker plant at no cost. Many producers have bull semen in their nitrogen tanks that they no longer intend to use and will eventually throw away. Often they will donate it rather than discard it. Contact local pork producers who are going on farm collection to get fresh boar semen. Some agriculture departments have insemination equipment that they have already been using for teaching purposes. If none is available, producers from your area will usually let you borrow theirs. The remaining equipment can be gotten from the biology or chemistry departments in your school.

3. Procedures for the Labs

After discussing the estrous cycle and parts of the reproductive tract, let students look at tracts on a table. Have them identify the parts you have just talked about. Note differences and similarities between two species. Also, note differences between heifers and cows, gilts and sows. Have students practice the insemination techniques using the tracts they have just examined.

Demonstrate proper thawing technique for bull semen. Have students try it and then load the insemination tube. Have them assemble the equipment for use in hogs also.

Motility can be checked under the microscope using semen they just thawed and the fresh boar semen. Demonstrate how excess cold, excess heat, and contact with water can change the motility of sperm.

4. The Practical Use of Artificial Insemination

The practical use of artificial insemination and cost to the producer should be discussed. Other related areas that may be covered are heat synchronization, embryo transfer, cloning, and gene splitting.

5. Tips for Teaching

Be comfortable with the material you are teaching. Know it well so you can field questions. Have a good technician teach you how to use the equipment. You may want to have a trial run before you do this with the students. Technicians, producers, or a representative from a breeding service are usually willing to visit with groups. A field trip to observe semen collection, actual insemination, or embryo transfer may be arranged.

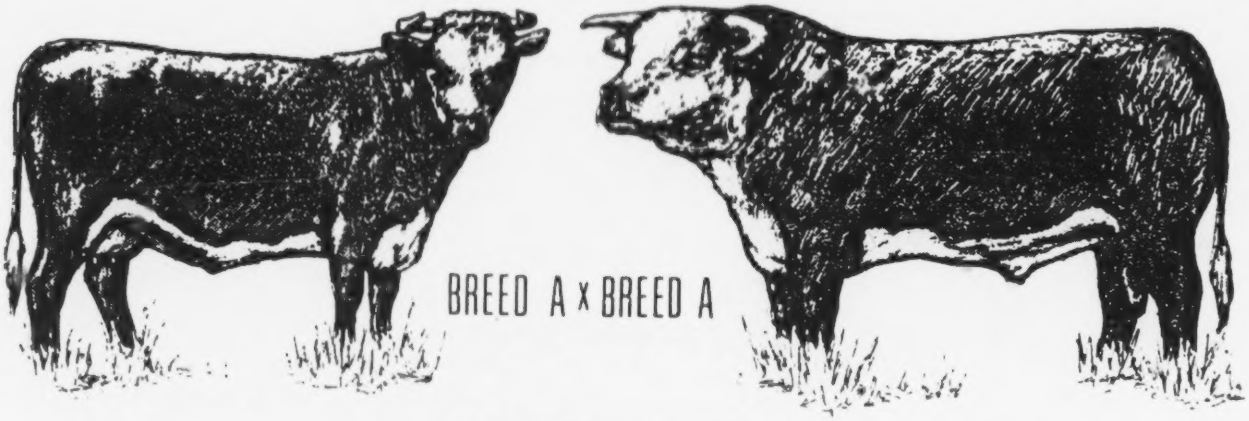
6. References

a. Hickenbottom, J.L. (1988). *Artificially Inseminating Livestock*. (VAS Unit #U1002c). Urbana, IL: Vocational Agriculture Service.
b. Bearden, H.J., and Fuquay, J.W. (1980). *Applied Animal Reproduction*. Reston, VA: Reston Publishing Company.
c. Ensminger, M.E. and Parker, R.O. (1986). *Sheep and Goat Science*. (5th ed.). Danville, IL: Interstate Publishers, Inc.
d. Lasley, J.F. (1981). *Beef Cattle Production*. Englewood Cliffs, NJ: Prentice-Hall.

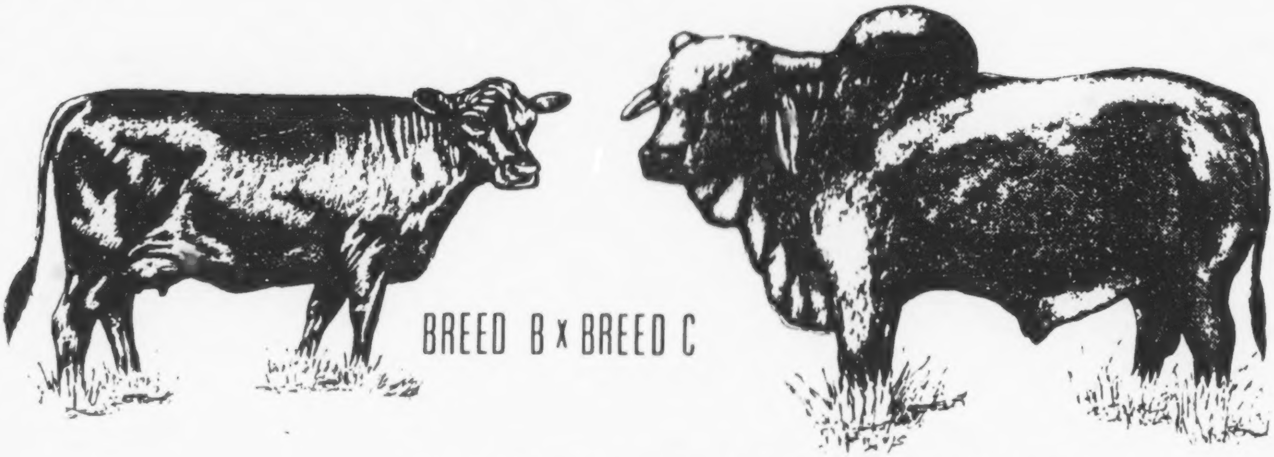
Presented by Jan Hickenbottom, Agriscience Teacher Inservice Program, January, 1989.

TRANSPARENCY MASTER #1

Systems of Breeding


BREED A x BREED A

1. Straightbreeding
   - -inbreeding
   - -linebreeding
   - -up-grading

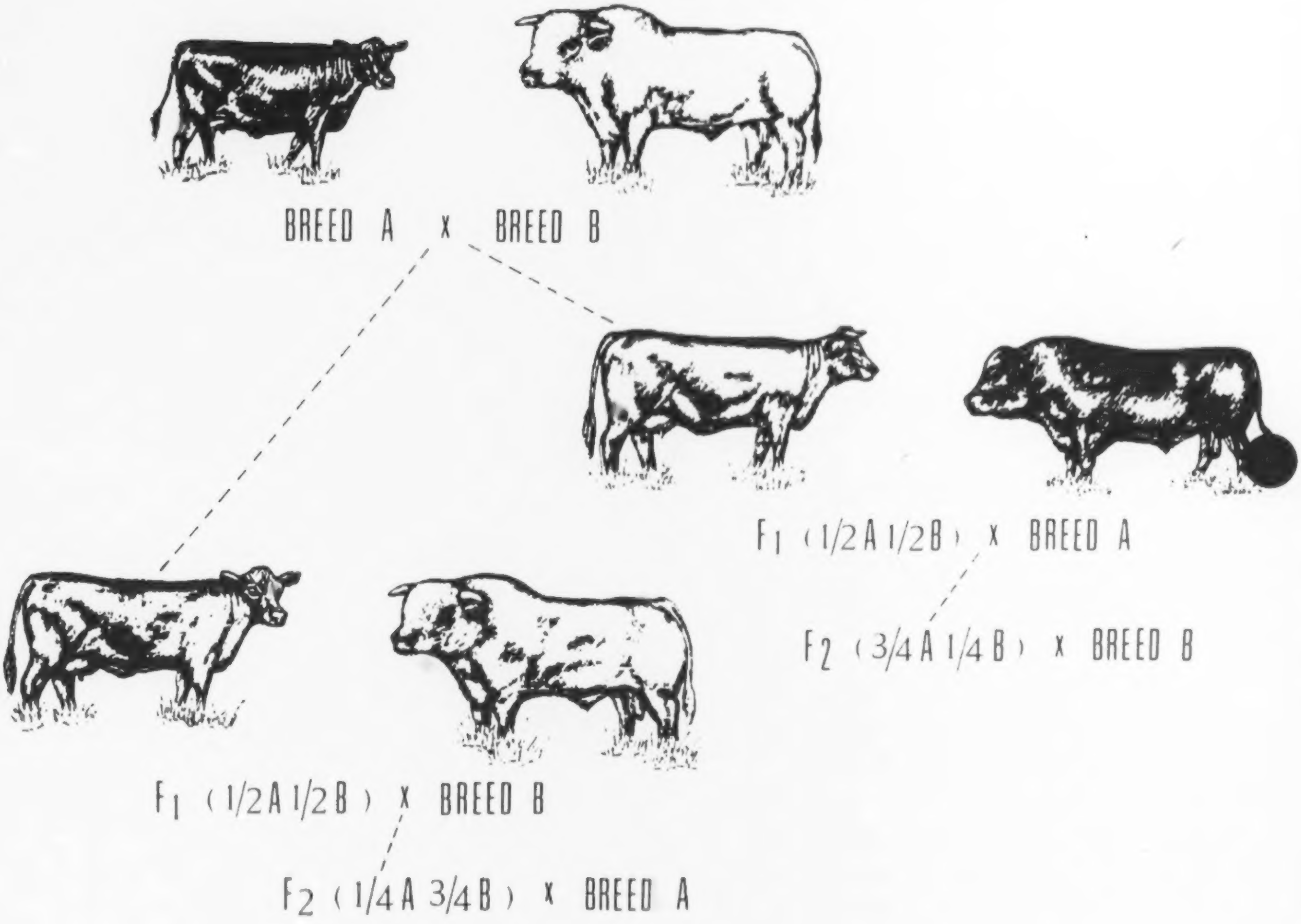

BREED B x BREED C

2. Outbreeding (Crossbreeding)

Vocational Agriculture Service — College of Agriculture — University of Illinois at Urbana - Champaign (Breeding 22)
From Lesson Plans for Voc. Agr. Instructors, Texas A & M University

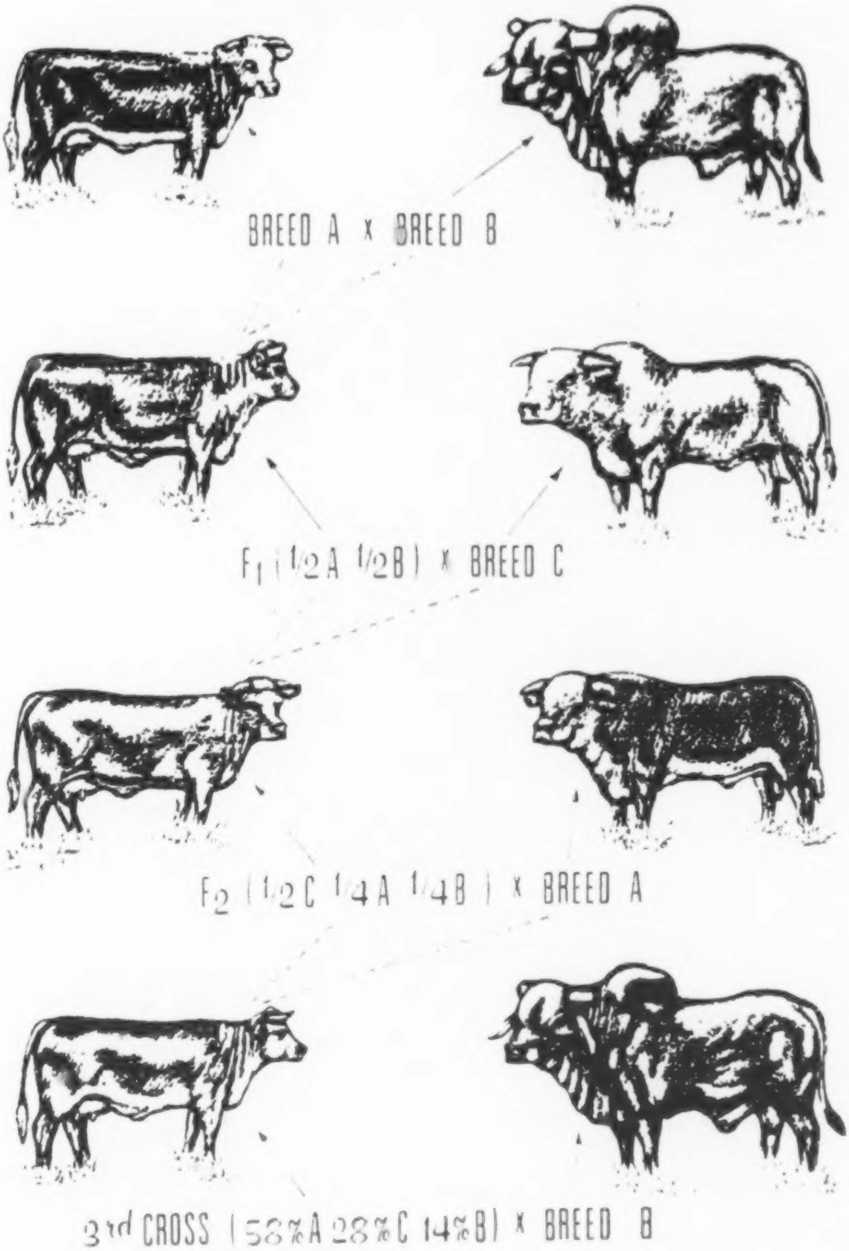
TRANSPARENCY MASTER #2

Crossbreeding (Crisscross Method)


BREED A x BREED B
F1 (1/2A 1/2B) x BREED A
F2 (3/4A 1/4B) x BREED B
F1 (1/2A 1/2B) x BREED B
F2 (1/4A 3/4B) x BREED A

TRANSPARENCY MASTER #3

Crossbreeding (Three - Breed Rotational Cross Method)


BREED A x BREED B
F1 (1/2A 1/2B) x BREED C
F2 (1/2C 1/4A 1/4B) x BREED A
3rd CROSS (58%A 28%C 14%B) x BREED B

Vocational Agriculture Service — College of Agriculture — University of Illinois at Urbana - Champaign (Breeding 29)
From Lesson Plans for Voc. Agr. Instructors, Texas A & M University

TRANSPARENCY MASTER #4

Amount of Inbreeding from Various Matings

Mating	Offspring
Brother x Sister Parent x Offspring	25% inbred
1/2 Brother x Sister Uncle x Niece Nephew x Aunt	12.5% inbred
1/2 Uncle x Niece Nephew x 1/2 Aunt	6.25% inbred
Cousin x Cousin	3.125% inbred

Vocational Agriculture Service — College of Agriculture — University of Illinois at Urbana - Champaign (Breeding 23)
From Lesson Plans for Voc. Agr. Instructors, Texas A & M University

TRANSPARENCY MASTER #5

The Reproduction Cycle in Farm Animals

Species	Length of Estrous Cycle (days)		Length of Estrus		Usual Time of Ovulation	Length of Gestation (days)		Age at Puberty (months)
	avg	range	avg	range		avg	range	
mare	21	10 - 37	5 - 6 days	1 - 14 days	24 - 48 hrs before end of estrus	336	310 - 350	10 - 12
cow	19 - 21	16 - 24	16 - 20 hrs	8 - 30 hrs	10 - 14 hrs after end of estrus	281	274 - 291	4 - 8
ewe	16	14 - 20	30 hrs	20 - 42 hrs	1 hr before end of estrus	150	140 - 160	4 - 8
sow	21	18 - 24	1 - 5 days	1 - 5 days	18 - 60 hrs after	112	111 - 115	5 - 7

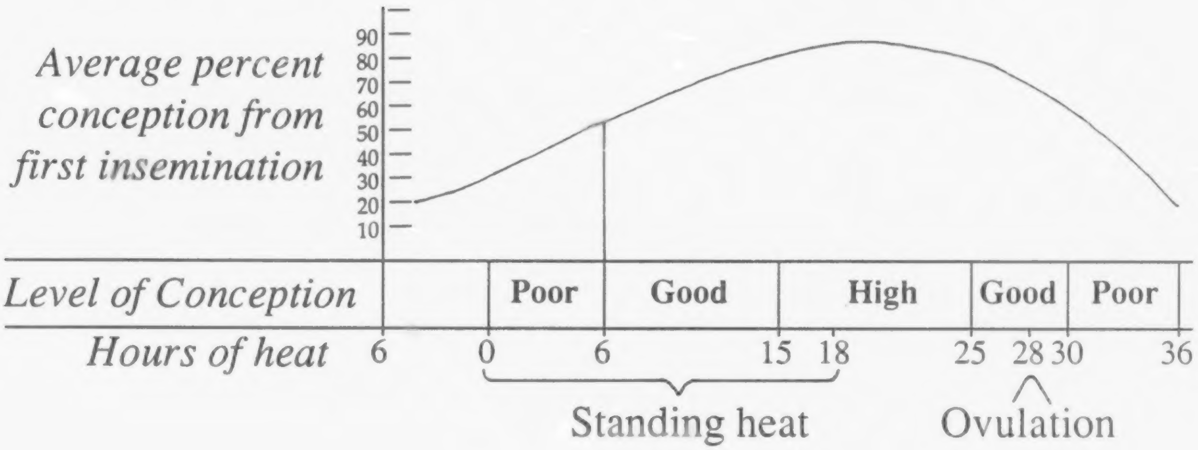
TRANSPARENCY MASTER #6

Estrous Cycle

Phase	**Action**
Proestrus ↓	1. Anterior Pituitary — *produces FSH(Follicle Stimulating Hormone)* 2. Ovary — *ovarian follicle produces estrogen*
Estrus ↓	3. Anterior Pituitary — *Produces LH* 4. Ovary
Metestrus ↓	5. Ovulation 6. C.L. Formation in follicle wall
Pregnancy ↓	7. • Pregnancy — *placenta produces estrogen and progesterone blocking LTH from anterior pituitary until parturition, then LTH and oxytocin initiate milk production*
Diestrus or Anestrus ↓	• No pregnancy a. If monestrous, then enter anestrus b. If polysestrus, then enter diestrus
Proestrus	8. Cycle repeats

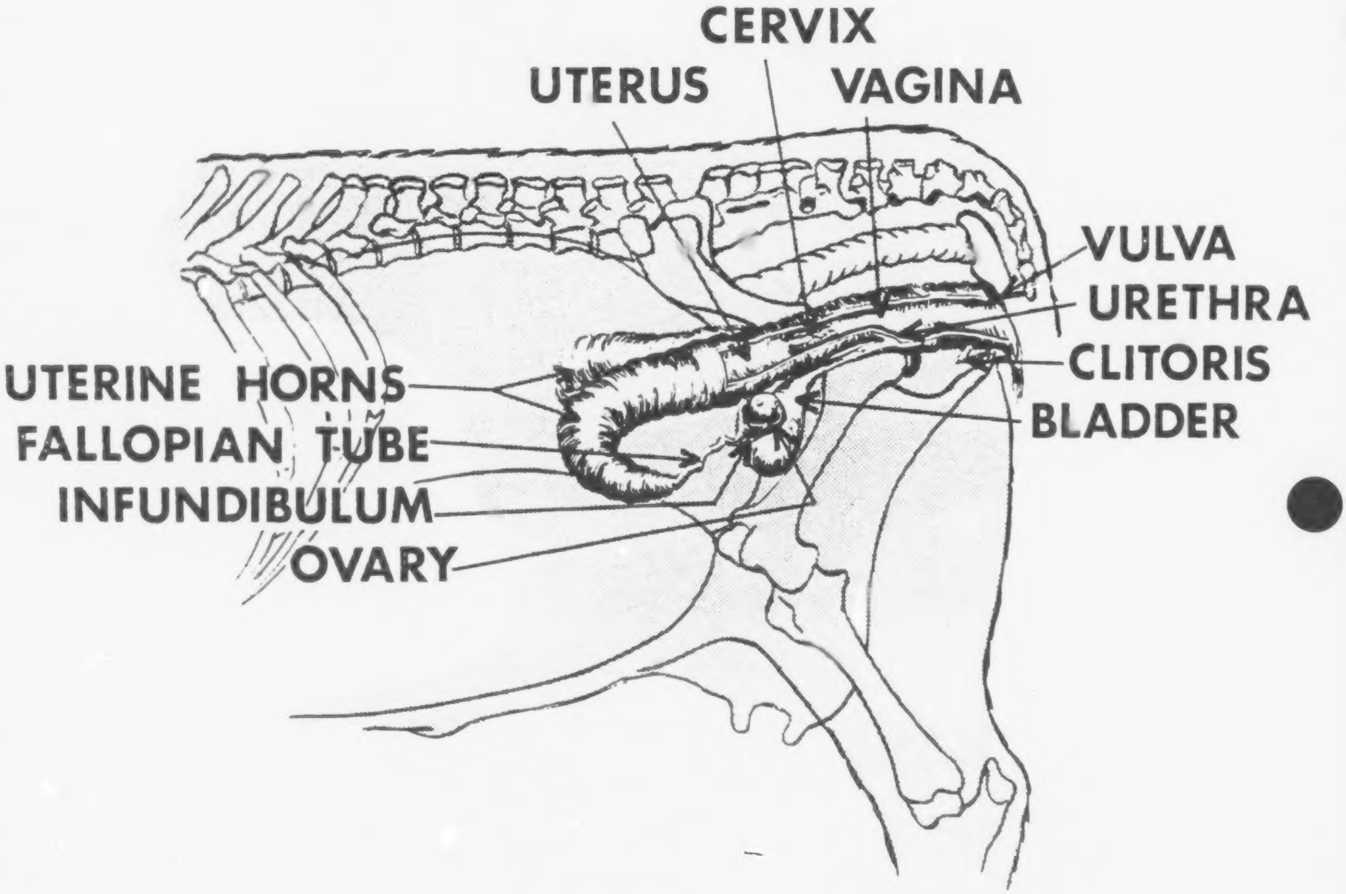
TRANSPARENCY MASTER 7

Time of Breeding and Conception Rate in Cattle



TRANSPARENCY MASTER #8

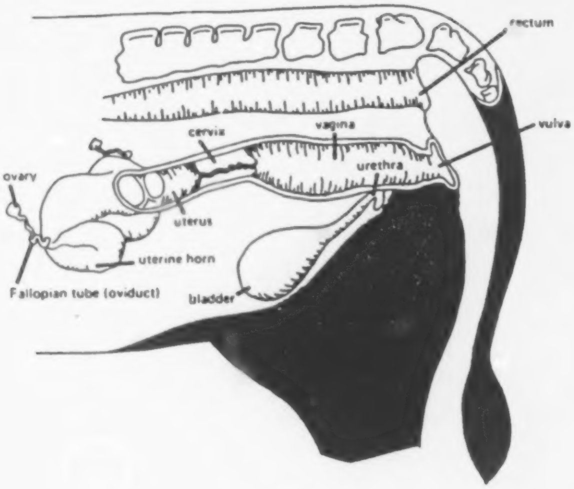
Female Reproductive System


CERVIX
UTERUS
VAGINA
VULVA
URETHRA
CLITORIS
UTERINE HORNS
BLADDER
FALLOPIAN TUBE
INFUNDIBULUM
OVARY

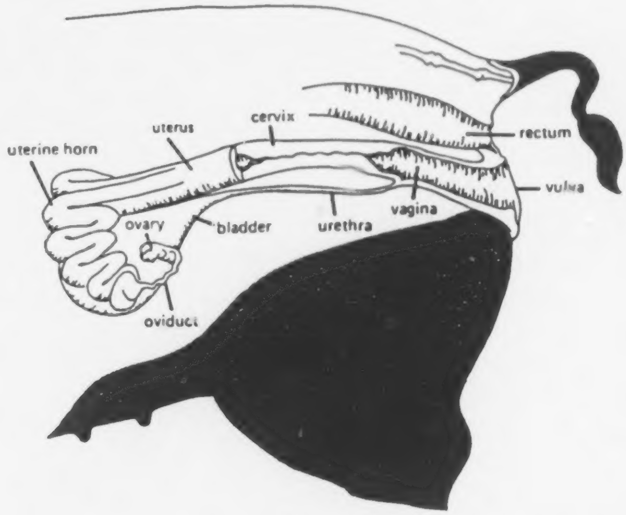
Vocational Agriculture Service — College of Agriculture — University of Illinois at Urbana - Champaign (Breeding 2)
From Lesson Plans for Voc. Agr. Instructors, Texas A & M University

TRANSPARENCY MASTER #9

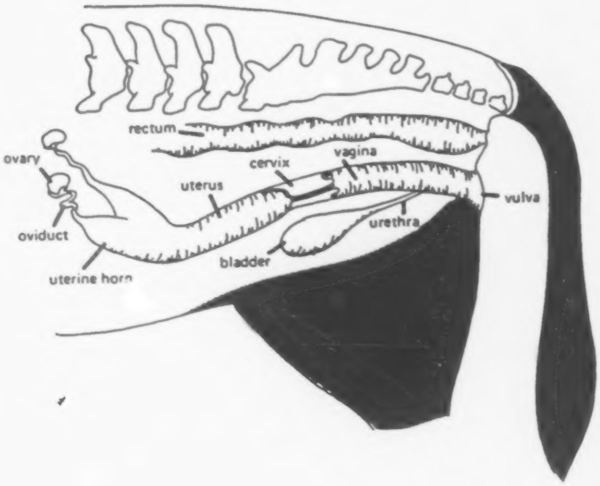
Comparison of Female Systems


rectum
vulva
cervix
vagina
urethra
ovary
uterus
uterine horn
Fallopian tube (oviduct)
bladder

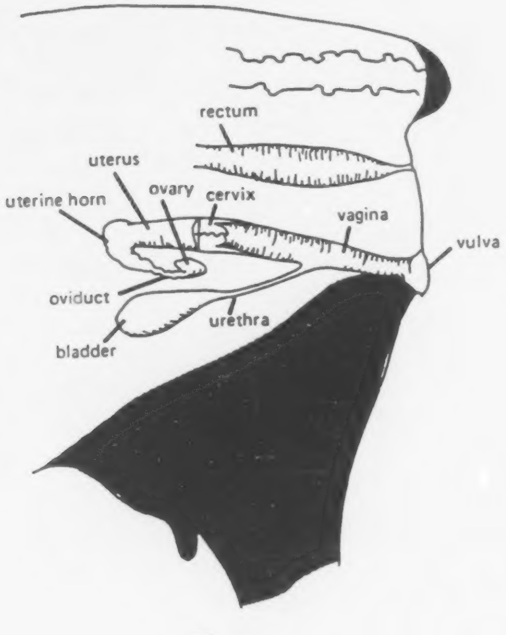
Cow


uterus
cervix
rectum
uterine horn
vulva
ovary
bladder
urethra
vagina
oviduct

Sow


rectum
ovary
cervix
vagina
uterus
vulva
urethra
oviduct
bladder
uterine horn

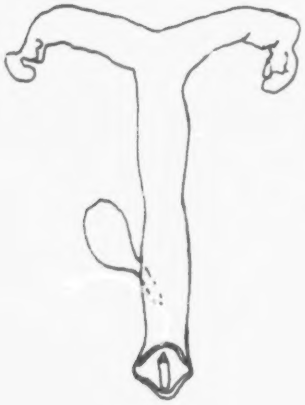
Mare


rectum
uterus
uterine horn
ovary
cervix
vagina
vulva
oviduct
urethra
bladder

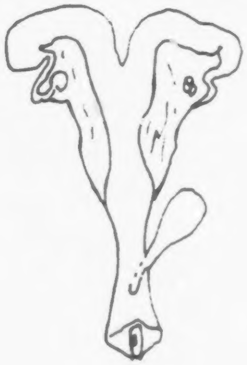
Ewe

TRANSPARENCY MASTER #10

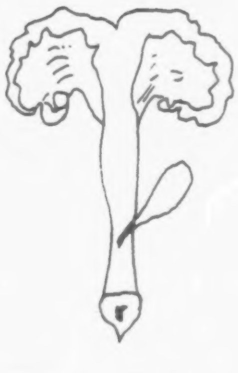
Uteri of Farm Animals



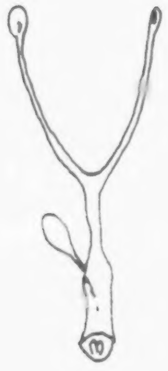
mare



cow



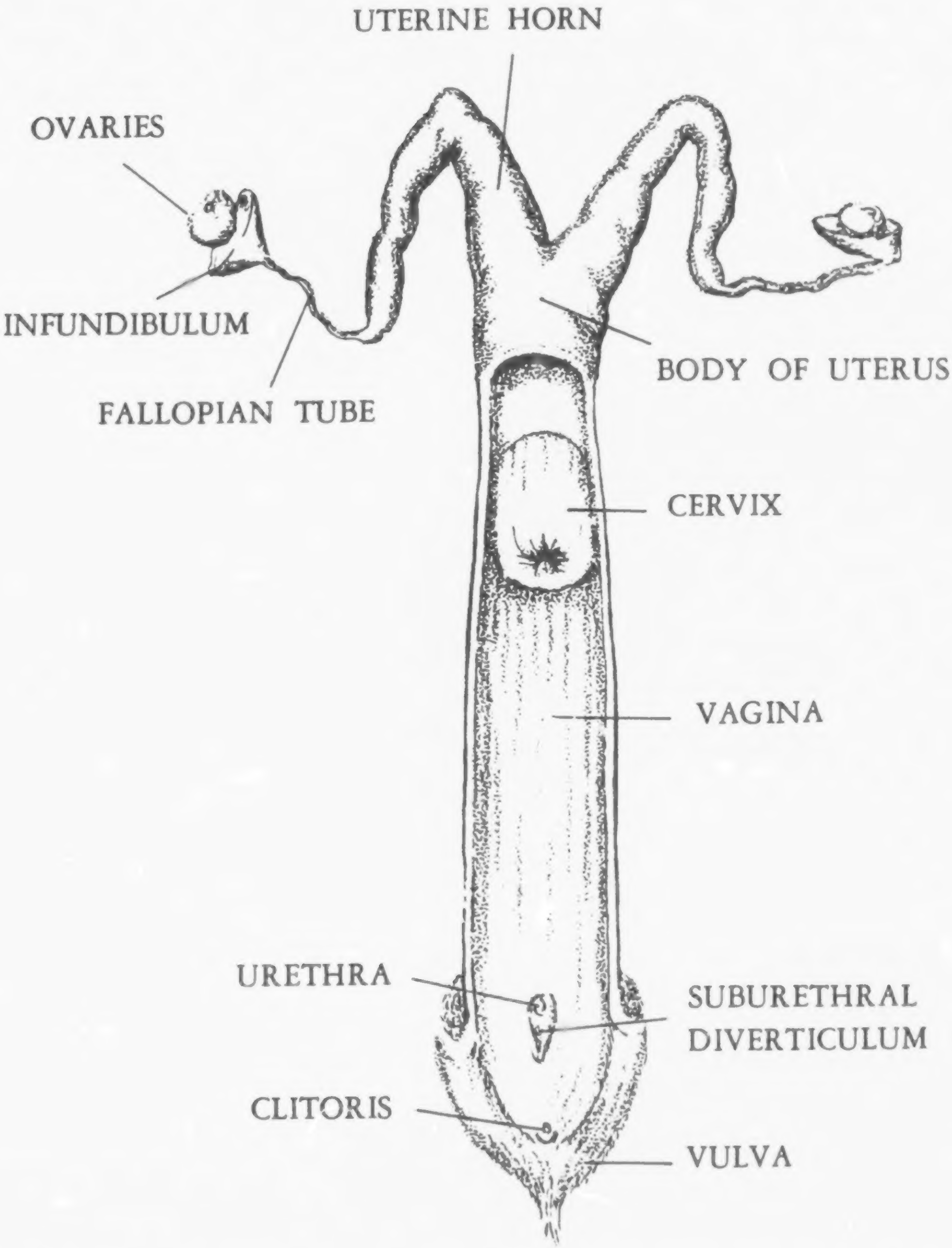
sow



bitch

TRANSPARENCY MASTER #11

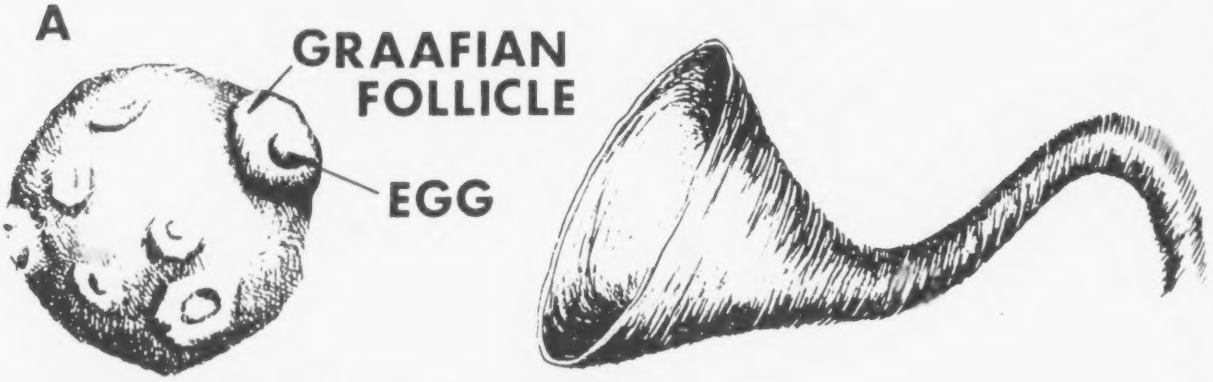
Female Reproductive Tract (top view)


UTERINE HORN
OVARIES
INFUNDIBULUM
FALLOPIAN TUBE
BODY OF UTERUS
CERVIX
VAGINA
URETHRA
SUBURETHRAL DIVERTICULUM
CLITORIS
VULVA

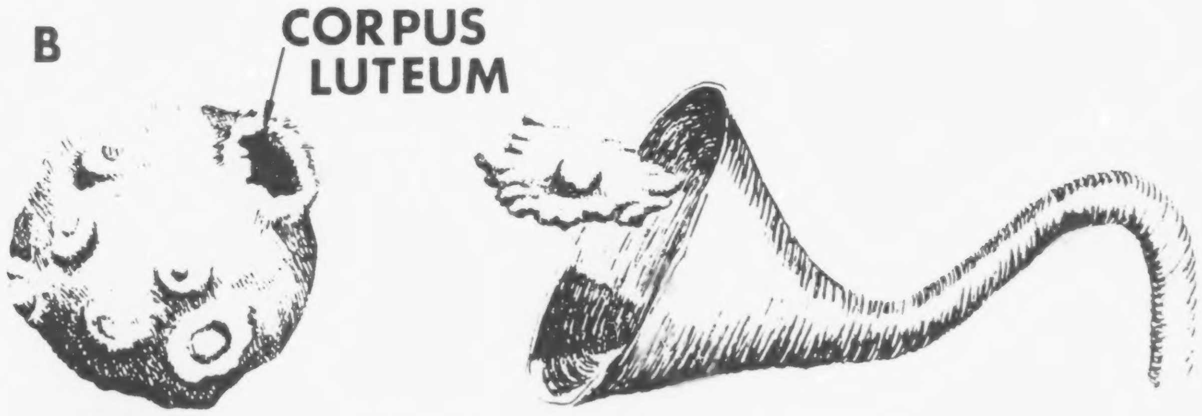
Vocational Agriculture Service — College of Agriculture — University of Illinois at Urbana - Champaign (Breeding 3)
From Lesson Plans for Voc. Agr. Instructors, Texas A & M University

TRANSPARENCY MASTER #12

Ovulation



OVARY (DURING HEAT)

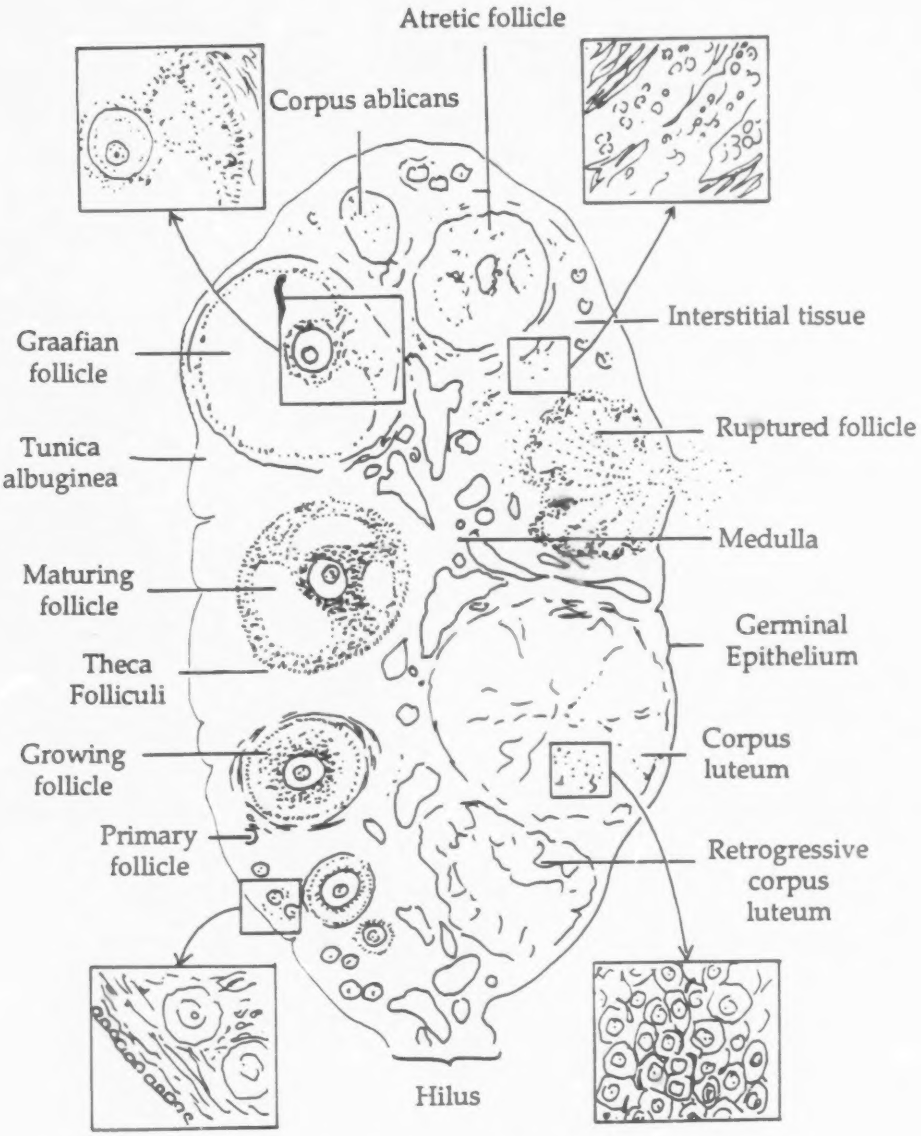


OVARY (NOT IN HEAT)

Vocational Agriculture Service — College of Agriculture — University of Illinois at Urbana - Champaign (Breeding 4)
From Lesson Plans for Voc. Agr. Instructors, Texas A & M University

TRANSPARENCY MASTER #13

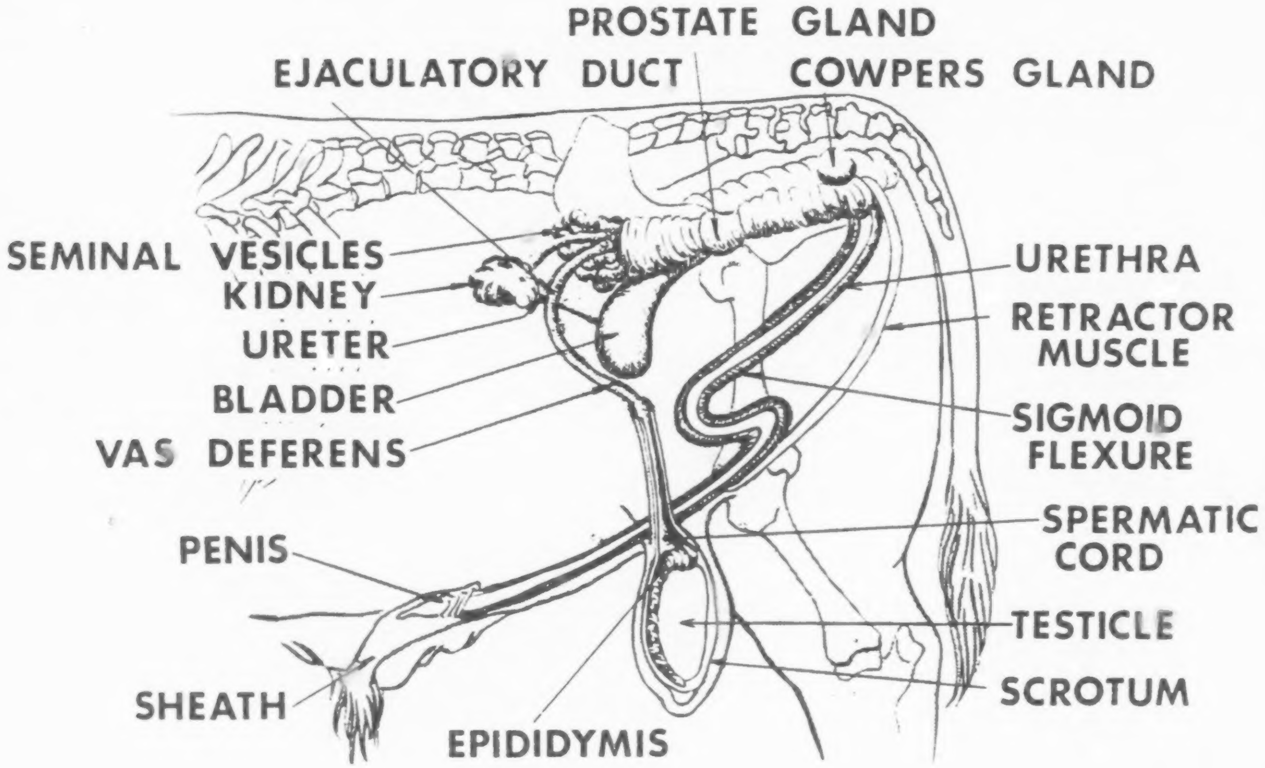
Composite Mammalian Ovary


Atretic follicle
Corpus ablicans
Interstitial tissue
Graafian follicle
Tunica albuginea
Ruptured follicle
Medulla
Maturing follicle
Germinal Epithelium
Theca Folliculi
Growing follicle
Corpus luteum
Primary follicle
Retrogressive corpus luteum
Hilus

Progressive stages in the differentiation of a Graafian follicle.

TRANSPARENCY MASTER #14

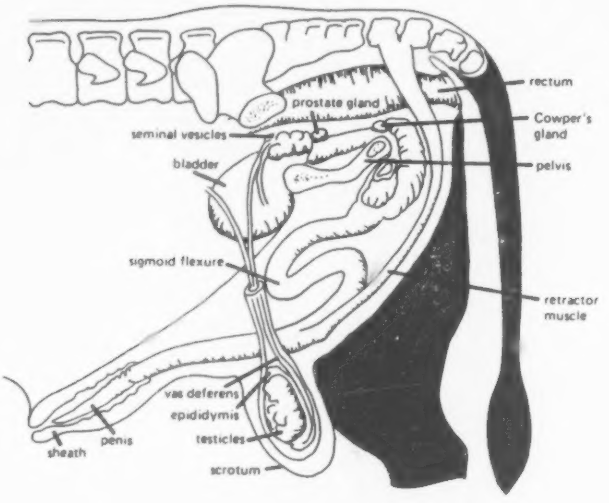
Male Reproductive System


PROSTATE GLAND
EJACULATORY DUCT
COWPERS GLAND
SEMINAL VESICLES
KIDNEY
URETER
BLADDER
VAS DEFERENS
PENIS
SHEATH
EPIDIDYMIS
URETHRA
RETRACTOR MUSCLE
SIGMOID FLEXURE
SPERMATIC CORD
TESTICLE
SCROTUM

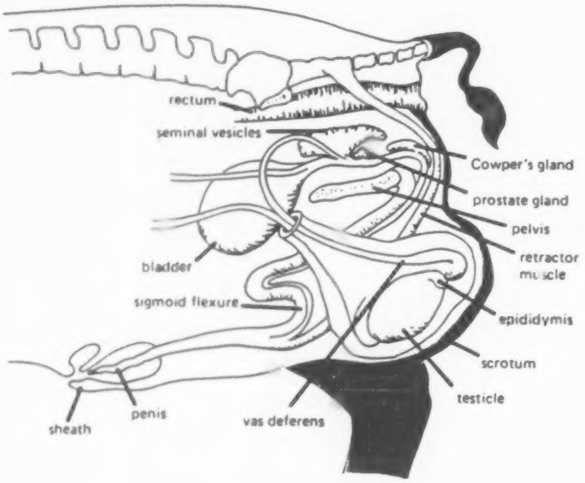
Vocational Agriculture Service — College of Agriculture — University of Illinois at Urbana - Champaign (Breeding 1)
From Lesson Plans for Voc. Agr. Instructors, Texas A & M University

TRANSPARENCY MASTER #15

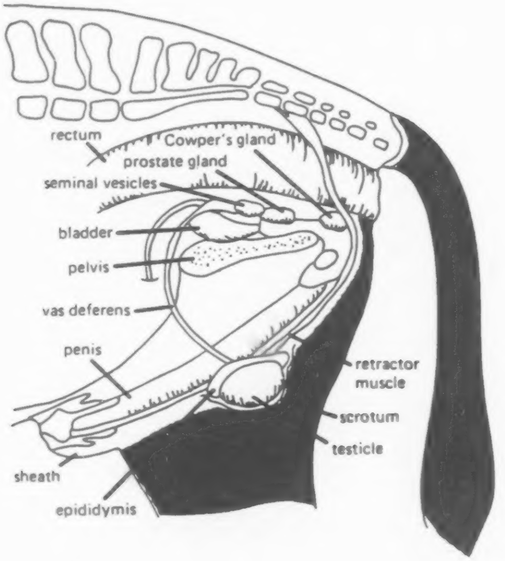
Comparison of Male Systems


prostate gland
rectum
seminal vesicles
Cowper's gland
bladder
pelvis
sigmoid flexure
retractor muscle
vas deferens
epididymis
testicles
penis
sheath
scrotum

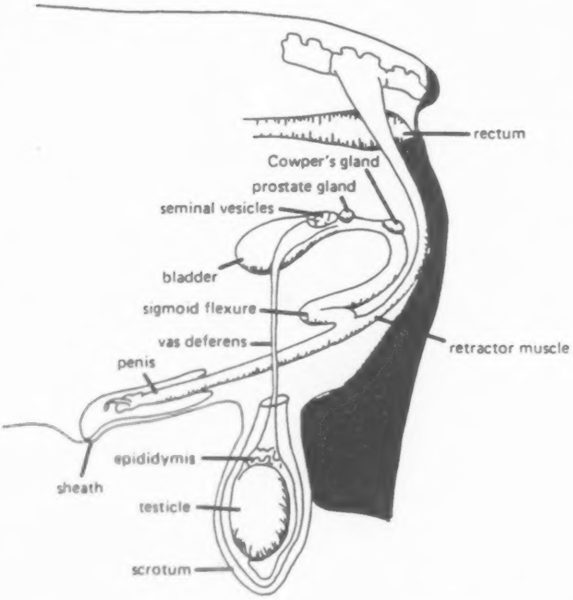
Bull


rectum
seminal vesicles
Cowper's gland
prostate gland
pelvis
retractor muscle
bladder
sigmoid flexure
epididymis
scrotum
testicle
sheath
penis
vas deferens

Boar


rectum
Cowper's gland
prostate gland
seminal vesicles
bladder
pelvis
vas deferens
penis
retractor muscle
scrotum
testicle
sheath
epididymis

Stallion

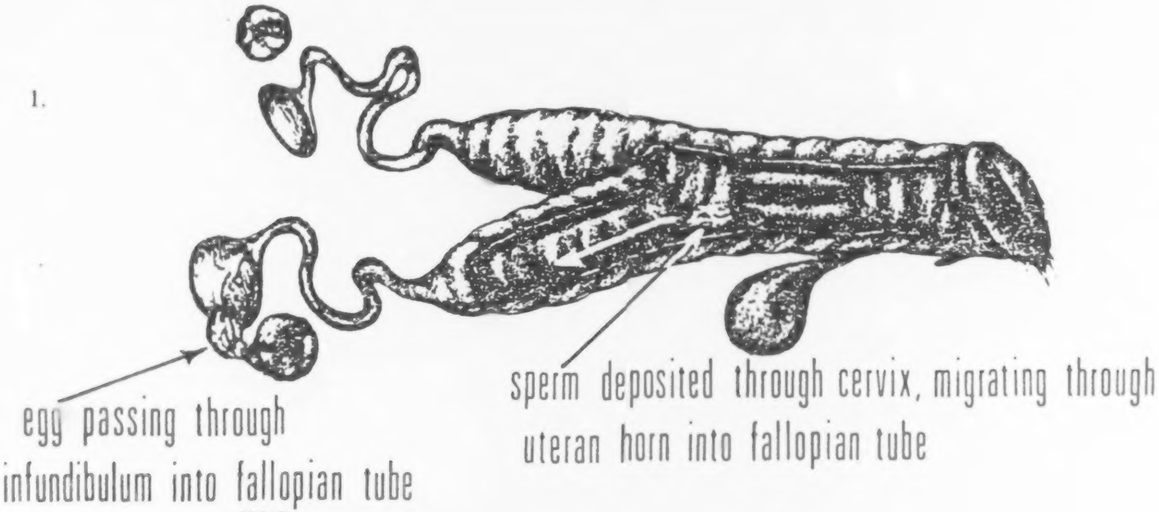

rectum
Cowper's gland
prostate gland
seminal vesicles
bladder
sigmoid flexure
vas deferens
retractor muscle
penis
epididymis
sheath
testicle
scrotum

Ram

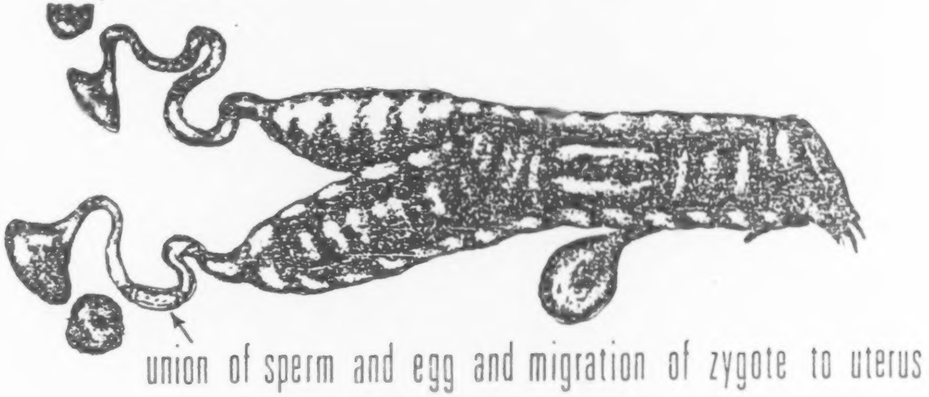
TRANSPARENCY MASTER #16

Fertilization in Cattle

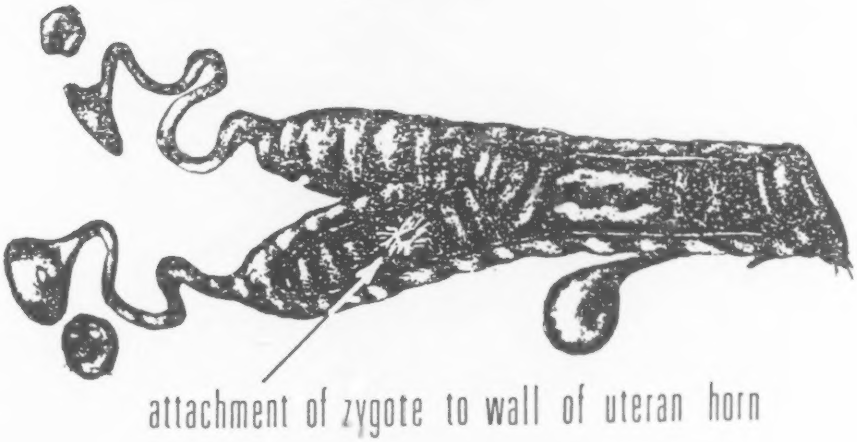
1.


egg passing through infundibulum into fallopian tube
sperm deposited through cervix, migrating through uteran horn into fallopian tube

2.


union of sperm and egg and migration of zygote to uterus

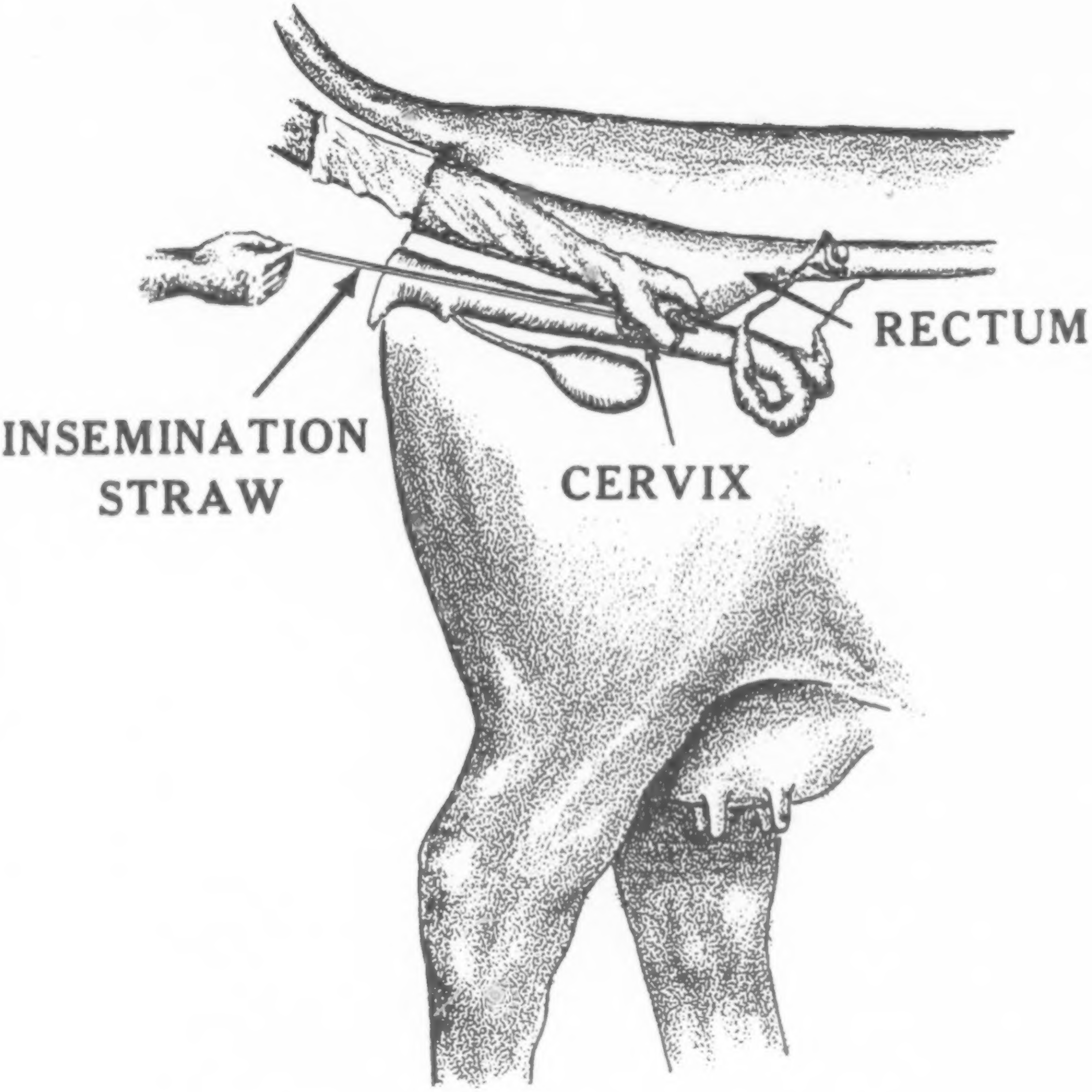
3.


attachment of zygote to wall of uteran horn

Vocational Agriculture Service — College of Agriculture — University of Illinois at Urbana - Champaign (Breeding 5)
From Lesson Plans for Voc. Agr. Instructors, Texas A & M University

TRANSPARENCY MASTER #17

Artificial Insemination



Vocational Agriculture Service — College of Agriculture — University of Illinois at Urbana - Champaign (Breeding 38)
From Lesson Plans for Voc. Agr. Instructors, Texas A & M University

TRANSPARENCY MASTER #18

Why Breed Artificially?

1. Maximum use of outstanding sires
2. Greatly increased uniformity
3. Possible to overcome certain physical handicaps to mating
4. Lessens sire cost
5. Alleviates danger and bother of keeping a sire
6. Reduces the cost and delays of using infertile sires
7. Better health protection
8. Improved herd records
9. Increases profits
10. Increases pride of ownership

Vocational Agriculture Service — College of Agriculture — University of Illinois at Urbana - Champaign (Breeding 30)
From Lesson Plans for Voc. Agr. Instructors, Texas A & M University

TRANSPARENCY MASTER #19

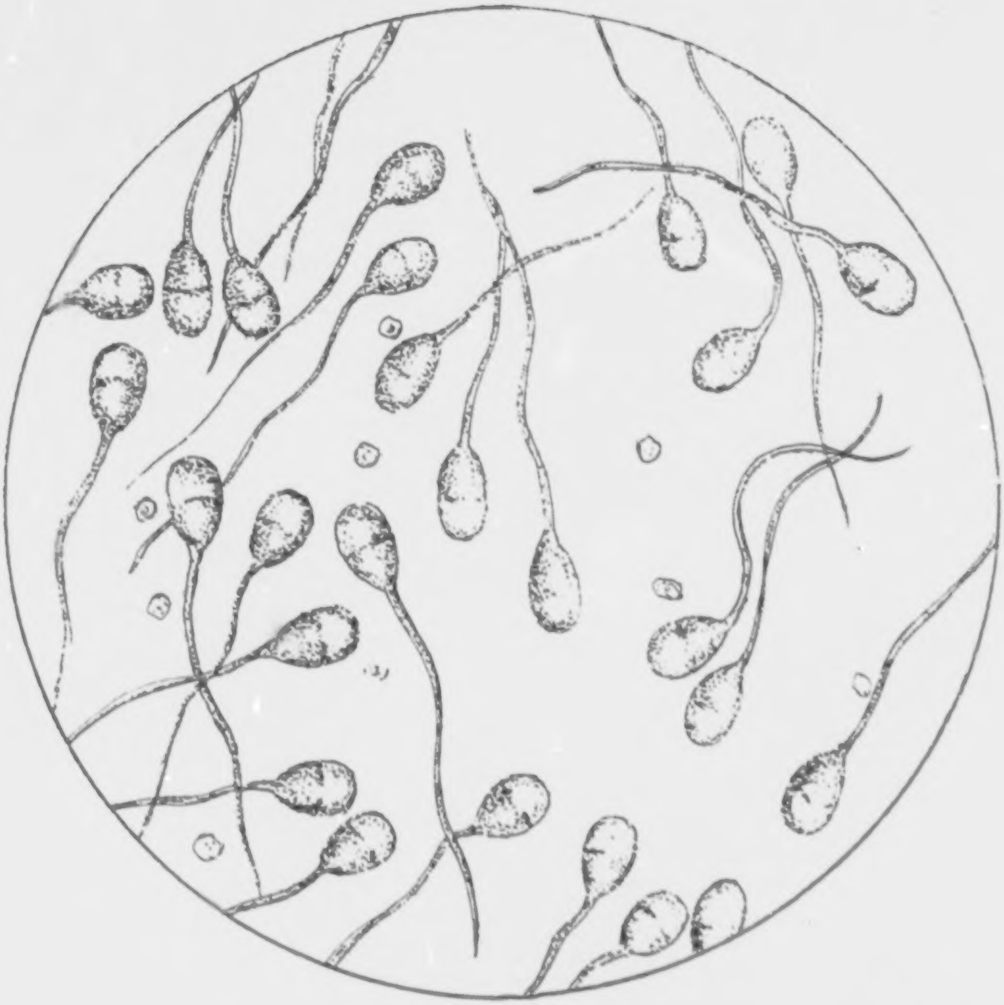
Limitations of Artificial Insemination

1. Requires skilled technician
2. Must conform to physiological principles
3. May restrict the sire market
4. May increase the spread of disease
5. May be subject to certain abuses
6. May accentuate the damage of a poor sire
7. Considerable capital and competent managerial ability are necessary to initiate and operate an artificial breeding organization

Vocational Agriculture Service — College of Agriculture — University of Illinois at Urbana - Champaign (Breeding 31)
From Lesson Plans for Voc. Agr. Instructors, Texas A & M University

TRANSPARENCY MASTER #20

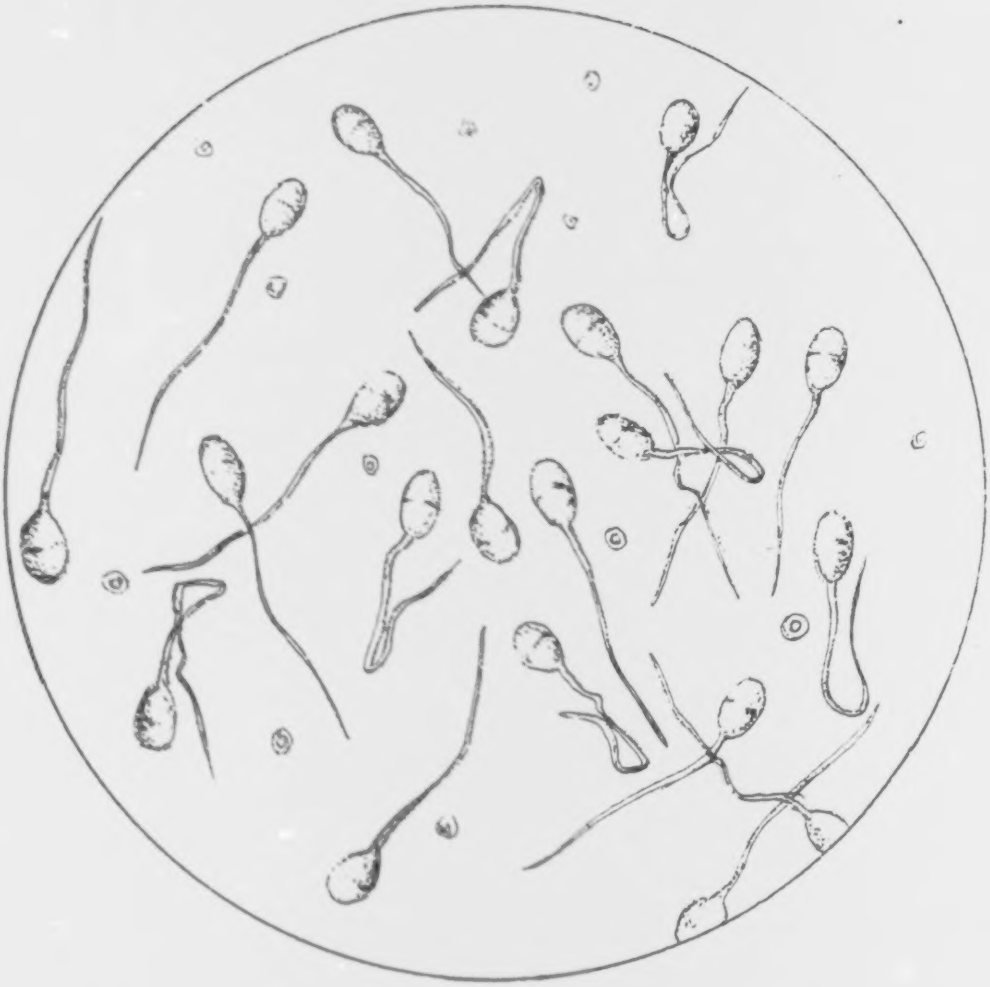
Good Semen



574

TRANSPARENCY MASTER #21

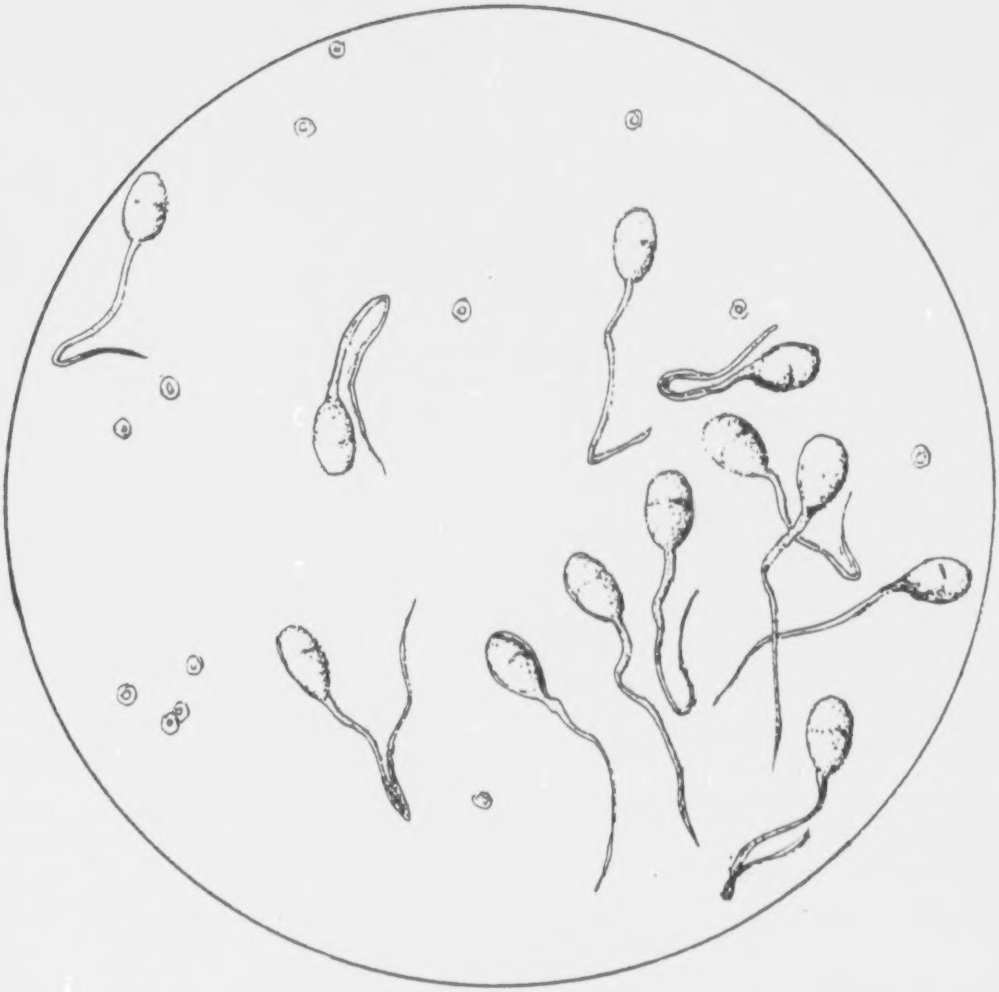
Questionable Semen



575

TRANSPARENCY MASTER #22

Poor Semen



TRANSPARENCY MASTER DISCUSSION GUIDE

Transparency Master #1

There are two systems of breeding livestock — *straightbreeding* and *outbreeding*. Straightbreeding is the mating of animals of the same breed, while outbreeding is the mating of unrelated animals.

Straightbreeding includes inbreeding, linebreeding, purebred breeding, and up-grading. The only method of outbreeding is *crossbreeding*. There are, however, several ways of crossbreeding.

Transparency Master #2

One method of crossbreeding is the crisscross method. With this method the breeder divides the F1 females into two breeding herds. Bulls of Breed A are mated to herd one, F1 females; and Bulls of Breed B are mated to herd two, F1 females. Each herd provides replacements for the other.

Transparency Master #3

The three-breed rotational plan for crossbreeding is possibly better than the crisscross method because maximum vigor is maintained. The breeds used to develop the F1 should be distinctly different. This system can be used very successfully by breeders who maintain three or more herds.

Transparency Master #4

This transparency shows the different matings that may be used for inbreeding and the amount of inbreeding in the offsprings from such matings. Production efficiency of animals with 6.25 percent or less of inbreeding is usually not affected.

Transparency Master #6

This transparency shows a diagrammatic representation of anterior pituitary involvement in ovulation, gestation, and hormonal release.

Transparency Masters #8 - #10

Ovaries — two organs near the posterior end of the reproductive tract. The ovaries contain many follicles in which eggs are produced. They secrete the female sex hormones estrogen and progesterone, and form the corpara lutea (plural of corpus luteum).

Oviducts (Fallopian tubes) — two tubes that carry eggs from the ovaries to the horns of the uterus. They lie close, but are not attached to the ovaries. The funnel-shaped end of each oviduct near the ovary is called an infundibulum.

Uterus (Womb) — an organ with two horns (branches) that are connected to the oviducts. Fetal development occurs here. The male semen is deposited either in the posterior uterus or mid-cervix regions.

Cervix — neck of the uterus. Separates the uterus from the vagina, acting as a valve.

Vagina — a passageway between the cervix and the vulva. The vagina expands to pass the fetus at birth.

Urethra — carries urine from bladder to vagina.

Clitoris — sensory and erectile organ of the female located just inside the vulva.

Vulva — the external opening of the reproductive and urinary tracts.

Transparency Master #11

The female mammal produces sex cells or eggs and furnishes a place within her body where these eggs, if fertilized, can grow and develop into young. The important parts of the female reproductive tract are the ovaries, oviducts or fallopian tubes, uterus, cervix, vagina, and vulva.

Transparency Master #12

A ripened follicle ruptures, discharging an egg, near the end of heat or after the heat period. The egg drops into one of the oviducts where it may be fertilized if a *viable* sperm is present.

The corpus luteum appears soon after ovulation and secretes the hormone progesterone. This (1) causes the uterus to implant and nourish the embryo, (2) prevents other eggs from maturing, (3) maintains pregnant condition, and (4) assists in the development of the mammary glands.

If the egg is not united with a sperm, the corpus luteum atrophies, allowing another follicle to ripen and another heat period to occur.

If more than one egg is released and fertilized, multiple births occur. Animals originating in this manner are fraternally related (fraternal twins, etc.) and are no more alike than brothers and sisters from separate births.. The occasional division of a single egg fertilized by a single sperm results in identical animals (identical twins).

Ovulation occurs at different times during and even after the heat period for different classes of livestock. This becomes especially important if the animal is bred by artificial insemination, and in determining breeding times for the ***hand-mating*** breeding system. For example, cows should be bred near the middle of the heat period, and sows should be bred on the second day of heat. Mares are normally bred on the second day of heat, and every other day thereafter throughout the heat period, because ovulation may occur at any time. The sperm will remain alive and viable for at least 24 hours within the female's reproduction tract.

Transparency Master #13

This transparency shows a diagram of a composite mammalian ovary. Progressive stages in the differentiation of a Graafian follicle are indicated on the left. The mature follicle may become atretic (top) or ovulate and undergo luteinization (right).

Transparency Masters #14 and #15

Scrotum — contains the testes. Helps maintain the temperature of the testes at about 5°F below body heat in order to prevent sterility.

Testes — produces the male sperm cells and testosterone, the male sex hormone.

Epididymis — long, greatly coiled tube which connects to each testicle. It functions in storage, maturation, and transportation of sperm cells.

Vas Deferens (sperm duct) — elongated tube which connects the epididymis with the urethra. Its function is transportation of sperm cells to the urethra.

Spermatic Cord — consists of vas deferens, smooth muscle, blood vessels, and nerves. It is enclosed in a protective, fibrous sheath.

Seminal vesicles — paired accessory glands which secrete seminal fluid into the urethra at the colliculus seminalis. The fluid functions in protection and as a transportation medium for the sperm.

Prostate Gland — found near the urethra and the bladder. It produces a fluid which is mixed with the seminal fluid.

Cowper's Gland — secretes a fluid similar to seminal fluid. It is secreted before ejaculation, and its purpose is to neutralize and cleanse the urethra.

Urethra — a tube extending from the bladder to the end of the penis. It functions as the transportation route for the semen and urine.

Semen — term given to the sperm plus the added necessary fluids (seminal and prostate fluids).

Penis — external organ which deposits sperm cells within the female reproductive tract. In animals with a fibroelastic penis, a *signoid flexure* allows the penis to be extended for copulation. Animals with a vascular penis have no such structure. The retractor penis muscle returns the penis into the *sheath* after mating.

Transparency Master #16

Fertilization is the union of the sperm and the egg. In the process of natural mating or artificial insemination, the semen containing the sperm is deposited within the vagina of the female. The sperm cells ascend the reproductive tract through the cervix, uterus, and into the oviducts. If the sperm cells are deposited at the proper time in relation to ovulation, a sperm will unite with an egg in the upper part of the oviduct. (In cattle, sperm live only 24 to 30 hours in the female reproductive tract and the unfertilized egg will live approximately 12 hours.)

The fertilized egg passes down the oviduct into the uterus. The embryo becomes attached to the mucous membrane of the uterus where it receives nourishment and is protected until fully developed. If no sperm unites with the egg, the female does not conceive, the egg cells are absorbed by the body, and the period recurs.

Transparency Master #17

Artificial insemination is the placing of sperm in the female reproductive tract by means other than natural means. There are various methods of artificial insemination for all types of livestock. However, artificial insemination is most effectively used in cattle, especially dairy cattle. Whatever the species, sperm is collected from the male first. This is accomplished through sexual stimulation by the handler or by electrical stimulation. After the sperm is ejaculated and collected, it is either used fresh or chemically extended and frozen for future use.

Artificial insemination in swine and sheep is in limited use. Whenever cows are artificially inseminated, fresh semen is normally used and the technician only enters the reproductive tract with the specially shaped inseminating instrument. In sheep, a speculum is placed in the ewe's vagina, and a semen filled catheter is lead through the speculum to be deposited.

The *rectovaginal* technique can be used with cows and mares. In this method, cover one hand with a rubber glove or disposable plastic glove-sleeve and insert it into the rectum. Most inseminators prefer to use the left hand for manipulation of the cervix through the rectal wall and the right hand for directing and controlling the inseminating tube.

STUDENT ACTIVITIES

STUDENT WORKSHEET #1 — Male and Female Reproductive Organs

STUDENT WORKSHEET #2 — Artificial Insemination and Reproductive Organs of Animals

STUDENT WORKSHEET #3 — Examining Semen Laboratory Exercise

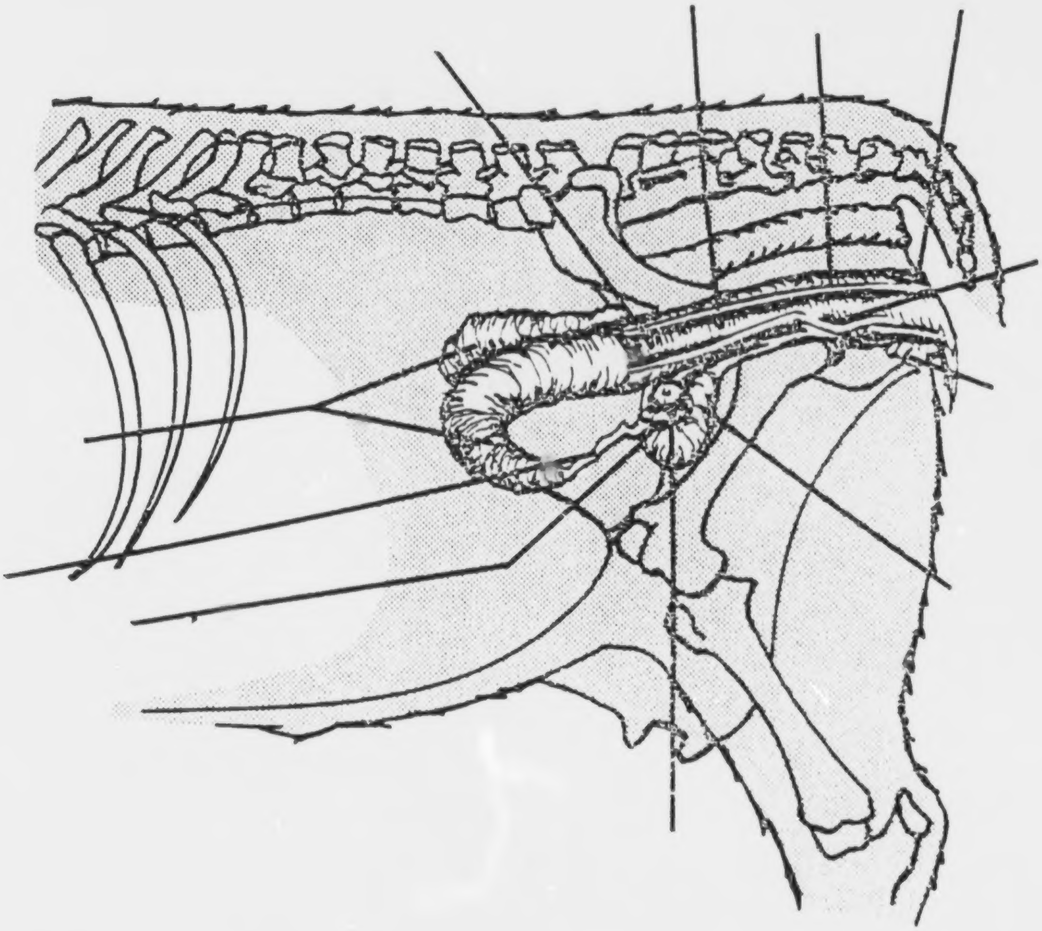
For additional activities, teachers may refer to the "Suggested Teaching Activities and Procedures" section in the Instructor's Guide.

STUDENT WORKSHEET #1

Male and Female Reproductive Organs

(Refer to VAS Unit #1002C, part 2.)

1. Label the identified parts of the female reproductive organs of the cow.



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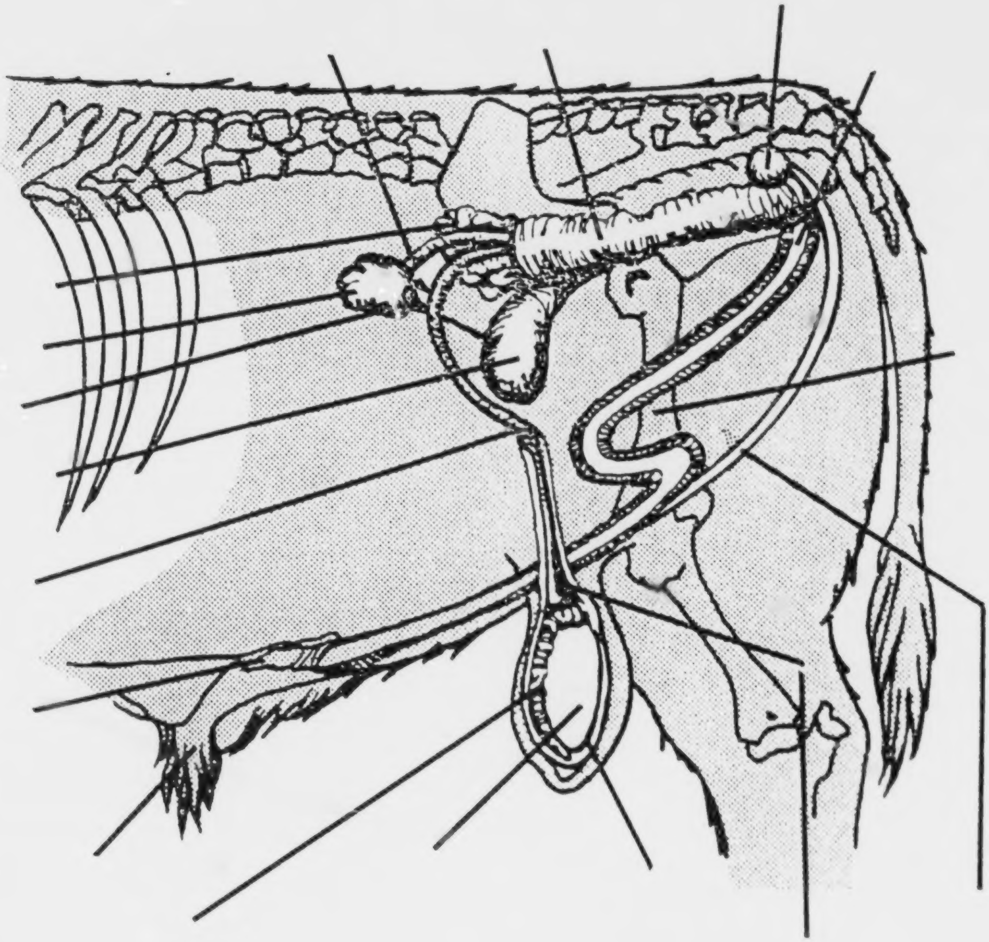
2. Label the identified parts of the male reproductive organs of the bull.

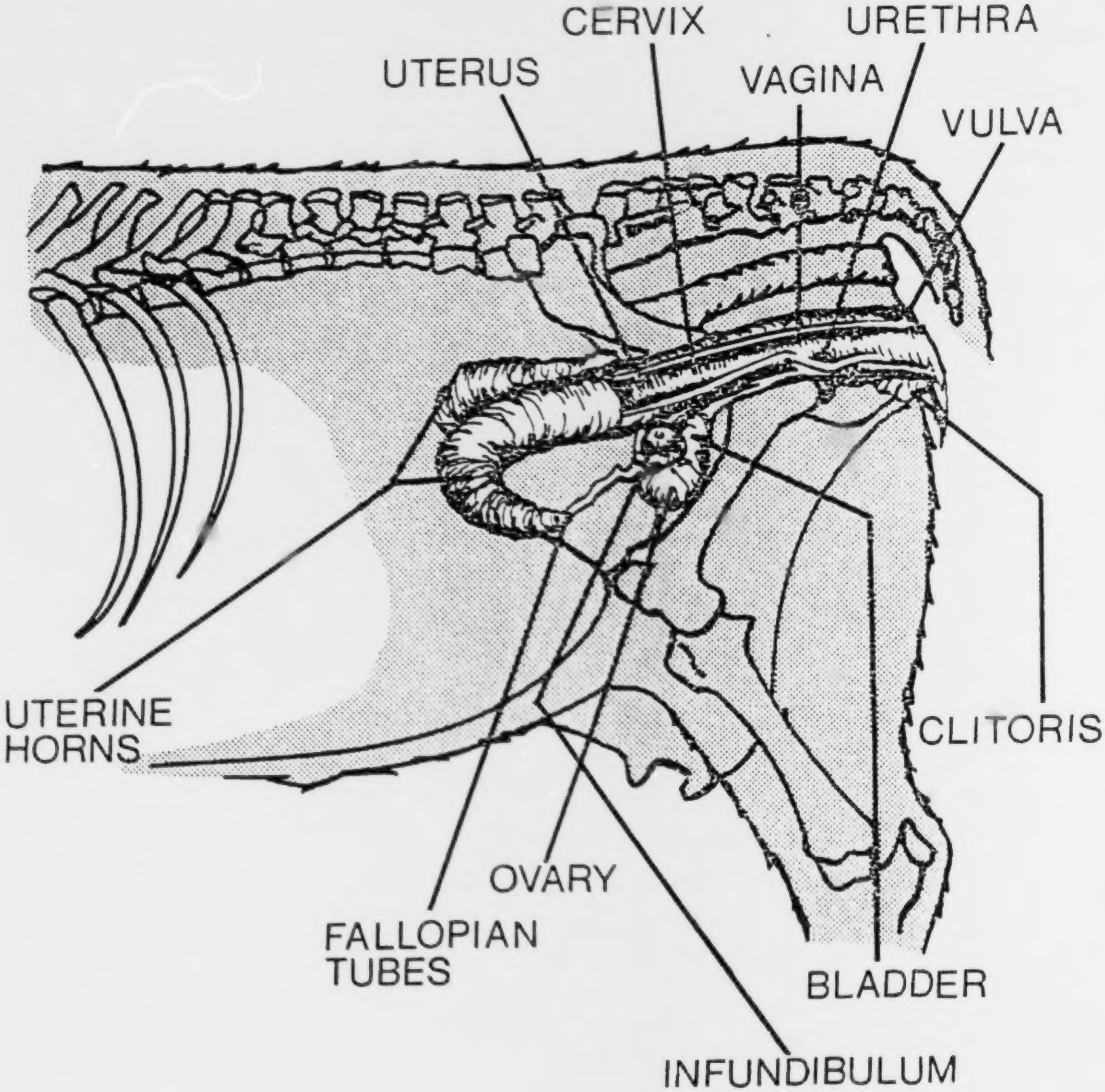


STUDENT WORKSHEET #1 — Key

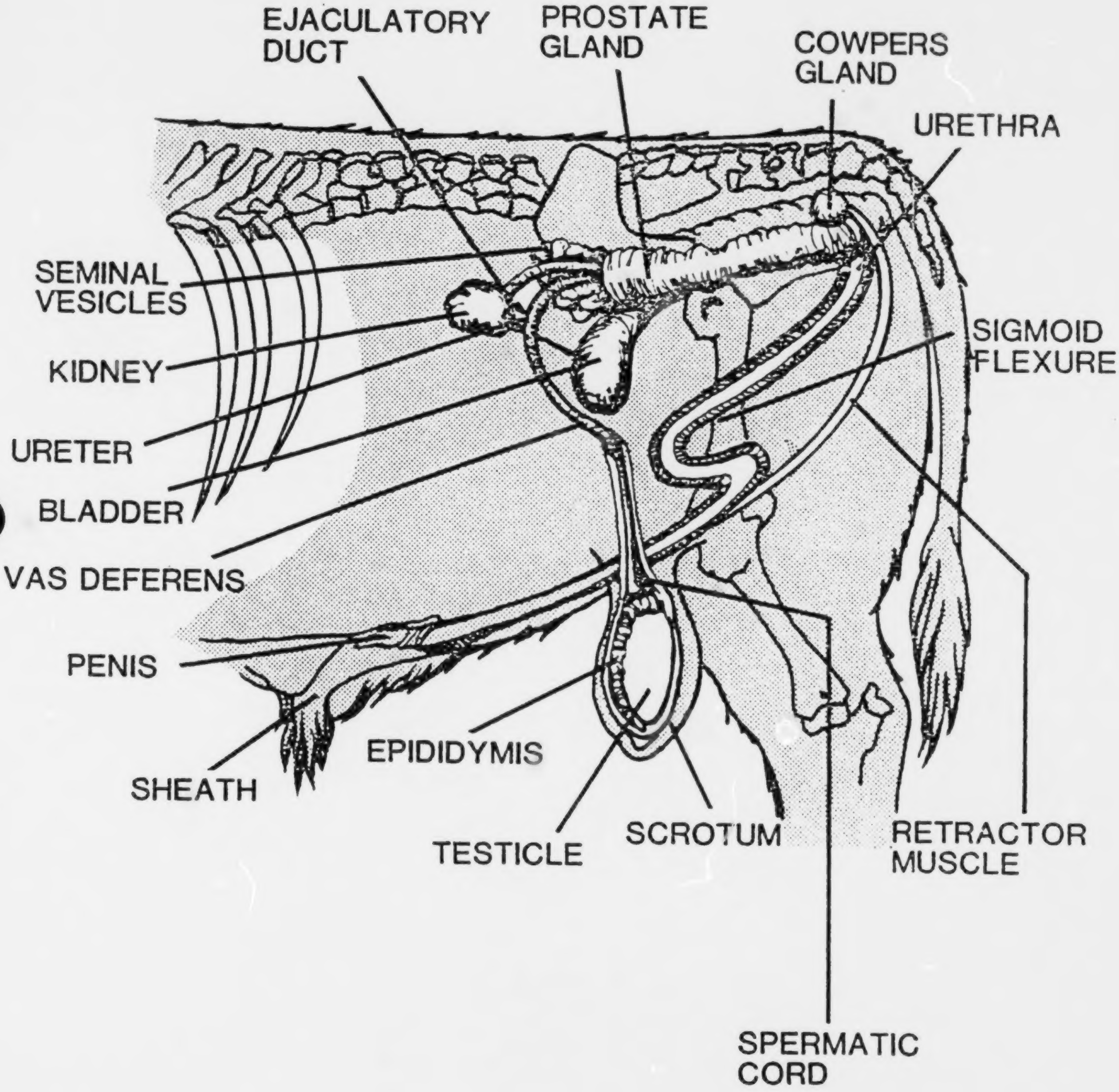
Male and Female Reproductive Organs

(Refer to VAS Unit #1002C, part 2.)

1. Label the identified parts of the female reproductive organs of the cow.


CERVIX
URETHRA
UTERUS
VAGINA
VULVA
UTERINE HORNS
CLITORIS
OVARY
FALLOPIAN TUBES
BLADDER
INFUNDIBULUM

2. Label the identified parts of the male reproductive organs of the bull.


EJACULATORY DUCT
PROSTATE GLAND
COWPERS GLAND
URETHRA
SEMINAL VESICLES
KIDNEY
URETER
BLADDER
VAS DEFERENS
PENIS
SHEATH
EPIDIDYMIS
TESTICLE
SCROTUM
SIGMOID FLEXURE
RETRACTOR MUSCLE
SPERMATIC CORD

STUDENT WORKSHEET #2

Artificial Insemination and Reproductive Organs of Mammals

(Refer to VAS Unit #1002C, *Artificially Inseminating Livestock*, parts 1 and 2.)

1. Define artificial insemination.

2. What are some of the advantages of artificial insemination?

3. What are some disadvantages of artificial insemination?

4. The____________mammal produces gametes or eggs and if they are____________, they can grow and develop into young offspring.

5. The two ___________produce the ova.

6. Usually in the cow and mare only one ________ is released during each ___________ or ________ _________.

7. It is in the _____________ that sperm cells meet and fertilize the ova.

8. The oviducts join with the horns of the ___________.

9. The embryo develops and grows in the ____________ _____________ until time of birth.

10. During pregnancy, the _________becomes sealed to prevent bacteria or other harmful materials from entering the uterus.

11. The _________ and _________ serve also to receive the __________ of the male at the time of mating.

12. The main function of the male in reproduction is the production of _________ cells.

13. The _________ produce sperm cells.

14. The process of sperm cell formation requires a temperature __________ that of the body and that is why the testes are suspended in the ___________.

15. The ______________ is the primary storehouse for millions of sperms.

16. The _______ ______________ connect the epididymis from each testis with an _____________.

17. Why are fluids added to the sperm?

    a.
    b.
    c.

18. The sperm follow the urethra through the ___________ to the exterior.

19. The penis of the bull, ram, and boar straightens by relaxation of the _____________ ______________ allowing the penis to be extended to deposit semen in the vagina of the female.

20. The penis of the stallion contains more ___________ tissue which becomes engorged with ___________ under proper stimulation causing erection for insertion into the vagina of the mare.

STUDENT WORKSHEET #2 — Key

Artificial Insemination and Reproductive Organs of Mammals

(Refer to VAS Unit #1002C, *Artificially Inseminating Livestock*, parts 1 and 2.)

1. Define artificial insemination.

   It is the placing of male reproductive cells in the female reproductive tract by using an inseminating tube rather than using direct service by the male.

2. What are some of the advantages of artificial insemination?
   - a. *The use of outstanding sires can be expensive.*
   - b. *It eliminates the cost and expense of buying and keeping a sire.*
   - c. *Mating of animals who are physically hundreds or thousands of miles apart.* can be accomplished
   - d. *It can test or prove an animal on a few females on a farm.*
   - e. *Valuable sires can be used even if they cannot mate naturally due to injury, age, size, or other physical handicaps.*
   - f. *Danger of spreading genital diseases is greatly reduced.*
   - g. *It encourages better breeding and birth records.*
   - h. *Risk and labor of keeping a sire can be eliminated.*
   - i. *Cooperative study of breeding problems should result in a more rapid advancement of the livestock industry.*

3. What are some disadvantages of artificial insemination?
   - a. *It requires a well-trained operator and special equipment.*
   - b. *It requires more time and supervision and better records than if the sire is running with the females.*
   - c. *All equipment and instruments used must be clean or infection may be spread.*
   - d. *The demand for a large number of sires could be reduced.*

4. The *female* mammal produces gametes or eggs and if they are *fertilized* , they can grow and develop into young offspring.

5. The two *ovaries* produce the ova.

6. Usually in the cow and mare only one *ovum* is released during each *estrous* or *heat* *cycle* .

7. It is in the *oviduct* that sperm cells meet and fertilize the ova.

8. The oviducts join with the horns of the *uterus* .

9. The embryo develops and grows in the *uterine* *horns* until time of birth.

10. During pregnancy, the *cervix* becomes sealed to prevent bacteria or other harmful materials from entering the uterus.

11. The *vagina* and *vulva* serve also to receive the *penis* of the male at the time of mating.

12. The main function of the male in reproduction is the production of *sperm* cells.

13. The *testes* produce sperm cells.

14. The process of sperm cell formation requires a temperature *below* that of the body and that is why the testes are suspended in the *scrotum*.

15. The *epididymis* is the primary storehouse for millions of sperms.

16. The *vas deferens* connect the epididymis from each testis with an *ampulla*.

17. Why are fluids added to the sperm?
    a. *To help transport sperm.*
    b. *To supply proper environment to keep sperm alive.*
    c. *To cleanse the urethra passageway.*

18. The sperm follow the urethra through the *penis* to the exterior.

19. The penis of the bull, ram, and boar straightens by relaxation of the *retractor muscle* allowing the penis to be extended to deposit semen in the vagina of the female.

20. The penis of the stallion contains more *erectile* tissue which becomes engorged with *blood* under proper stimulation causing erection for insertion into the vagina of the mare.

STUDENT WORKSHEET #3

Examining Semen Laboratory Exercise

Objective: To observe and check sperm for mobility and abnormality.

Materials: Microscope and slides
Semen sample

Procedure:

1. Prepare a slide with semen sample for microscope.
2. Check the sample for mobility.
    a. Progressive ____________
    b. Oscillatory ____________
    c. Rotary ____________
    d. No movement ____________
3. Check the sample for abnormality
    a. Tailless head ____________
    b. Two tails ____________
    c. Two heads ____________
    d. Pear-shaped head ____________
    e. Other ____________
4. Draw and label a normal sperm cell.

Questions:

1. At what temperature should semen be refrigerated?
2. What is the color of sperm?
3. Can an abnormal sperm fertilize an egg?
4. How and why do the sperm move?

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Maintaining Animal Health

RELATED PROBLEM AREAS:

1. Understanding Animal Anatomy and Physiology
2. Meeting Nutritional Needs of Animals
3. Understanding Animal Breeding and Reproduction
4. Meeting the Environmental Requirements of Animals

PREREQUISITE PROBLEM AREA(S)

1. Basic Principles of Animal Science (Central Core Cluster)

LEVEL: Preparatory

OCCUPATIONAL TASKS ADDRESSED:

Agricultural Business and Management Cluster

Duty A: Formulating Livestock Feeding Programs

1. Mix feed additives and medications

Duty H: Managing the Business

1. Conduct periodic inspection of merchandise
2. Conduct inventory of merchandise
3. Maintain inventory records
4. Purchase machinery and equipment

Duty I: Assembling, Servicing, and Maintaining Equipment and Facilities

1. Maintain hand tools
2. Perform maintenance checks on equipment
3. Sterilize injection equipment
4. Sterilize surgical instruments and equipment using chemical methods

Duty O: Maintaining Animal Health

1. Inspect animals for disease
2. Identify ailments in animals
3. Administer medication
4. Control parasites (external or internal)
5. Disinfect buildings and equipment

STATE GOALS FOR LEARNING

In planning the instruction for this problem area, teachers can promote the development of several student learning objectives which are related to the State Goals for Learning in the Biological and Physical Sciences. These objectives are listed on the Learning Assessment Plan forms included on the following page(s). Those learning objectives marked with an asterisk (*) are taken from the sample lists provided by the Illinois State Board of Education.

Illinois Agricultural Core Curriculum
Agricultural Education 124 Mumford Hall 1301 W. Gregory Drive University of Illinois Urbana, IL 61801

Director: Dale A. Law, Ed.D.
Principal Investigator: Jerry D. Pepple, Ed.D.
Research Assistant: Robert E. Petrea

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date ____________
☐ Original submission ☐ Revision
Page ____ of ____

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☒ Sciences ☐ Physical Development/Health

(Affix label or complete district information.)

COUNTY	DISTRICT	ESC
☐☐☐	☐☐☐☐	☐☐

District Name
City

II. STATE GOAL FOR LEARNING
As a result of their schooling, students will have a working knowledge of the concepts and basic vocabulary of biological, physical, and environmental sciences and their application to life and work in contemporary technological society.

Contact Person: ____________
Title: ____________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Understand the principle of cause and effect as it applies to disease.					
*2. Understand major body systems.					
3. Define terms integral to animal health.					
4. Describe characteristics of animals in good health.					
5. Relate physiological characteristics with specific domesticated animals.					
6. Describe common diseases and parasites that affect animals.					
7. List methods commonly used in the prevention and treatment of diseases and parasites.					

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ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date ____________
☐ **Original submission** ☐ **Revision**
Page ____ of ____

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☒ Sciences ☐ Physical Development/Health

(Affix label or complete district information.)
COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐
District Name
City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will have a working knowledge of the processes, techniques, methods, equipment, and available technology of science.

Contact Person: ____________
Title: ____________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
1. Identify types of equipment used in maintaining animal health and demonstrate their proper use.					
2. List methods commonly used in the prevention and treatment of diseases and parasites.					

Maintaining Animal Health

Agricultural Business and Management
Animal Science

ISBE 41-78 (1/88)

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Maintaining Animal Health

STUDENT LEARNING OBJECTIVES

Upon completion of their study of this problem area, students will be able to:

1. Define terms integral to animal health.
2. Describe characteristics of animals in good health.
3. Relate physiological characteristics with specific domesticated animals.
4. Identify types of equipment used in maintaining animal health and demonstrate their proper use.
5. Describe common diseases and parasites that affect animals.
6. List methods commonly used in the prevention and treatment of diseases and parasites.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Maintaining Animal Health

PROBLEMS AND QUESTIONS FOR STUDY	INSTRUCTOR'S NOTES AND REFERENCES
1. What does a healthy animal look like?	
2. How does a healthy animal act?	
3. What factors need to be considered to maintain an animal's health?	
4. How can one tell if an animal is ill?	
5. How are diseases transmitted?	
6. What are the major diseases of specific animal species?	
7. What are common parasites of animals?	
8. What equipment is used to maintain an animal's health?	
9. How is health maintenance equipment used?	
10. How can one prevent diseases from occurring?	
11. If a disease occurs, what should be done to treat that disease?	

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INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Maintaining Animal Health

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES

1. Use locally available persons as resources for information on maintaining animal health.
2. Conduct field trips to production facilities to see the practical aspects of the material presented.
3. Ask extension personnel, animal producers, and veterinarians to be guest lecturers and present demonstrations on equipment used in maintaining animal health.
4. Coordinate a visit to a local farm with a scheduled veterinary visit to allow students to observe and participate in various routine procedures.
5. Use Student Worksheet #1 as a laboratory exercise to allow students to handle syringes and medication equipment. Demonstrate the correct procedure to fill, remove air from, use, and sterilize syringes. Allow students to practice these procedures.
6. Arrange for students to assist a local producer in giving newborn pigs injections of antibodies and iron.
7. Use slides of livestock operations and have students identify examples depicted in the slides of sanitation, housing, equipment, and medication storage. Have them describe methods of correction to any problem situations they observed. Ask students, "What would you do in this situation?" and "How could you correct this situation in a practical manner?"
8. Have students develop a schedule of routine vaccinations and medications for a specific animal enterprise.
9. Assign the students a specific production facility and have them compile a list of medications used for maintaining animal growth in that facility.
10. Promote the adoption of recommended practices in student's SAE programs.
11. Use periodical journals for specific animal procedures and as resources on current animal health topics.
12. Use texts such as *The Stockman's Handbook* or specific animal texts as student references and resources to complete Student Worksheet #2.
13. Obtain one of the films, *Animal Welfare: The Farmer's Story,* or *Animal Welfare,* for student viewing. Have students discuss the film after viewing it.
14. Use appropriate VAS and Instructional Materials Units as student references and resources for study guides.
15. Use Student Worksheets #3 and #4 for individual assignments to demonstrate equipment use and to make an inventory of medications found at a target location.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Maintaining Animal Health

REFERENCES

*1. *The Stockman's Handbook.* (1983). Ensminger, M.E. Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

2. *Animal Science.* (1983). Ensminger, M.E. Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

3. *Beef Cattle Science.* (1983). Ensminger, M.E. Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

4. *Dairy Cattle Science.* (1983). Ensminger, M.E. Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

5. *Sheep and Wool Science.* (1983). Ensminger, M.E. Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

6. *Swine Science.* (1983). Ensminger, M.E. Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

7. *Horses and Horsemanship.* (1983). Ensminger, M.E. Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

8. *Poultry Science.* (1983). Ensminger, M.E. Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

*9. *Animal Welfare: The Farmer's Story.* American Farm Bureau Federation, 225 Touhy Ave, Park Ridge, IL 60068.

10. *Managing the Beef Cow Herd* (VAS Unit #U1010B); *Raising Dairy Heifers and Bulls* (VAS Unit #U1022); *The Swine Enterprise* (VAS Unit #U1029A); *The Sheep Enterprise* (VAS Unit #U1031A); *Caring for the Brood Mare and Foal* (VAS Unit #U1041); *Health Problems —Beef Cow Herd* (VAS Unit #U1054); *Approved Practices for Beef* (VAS Approved Practices #A100); *Approved Practices for Sheep* (VAS Approved Practices #A140); *Approved Practices for Swine* (VAS Approved Practices #A160; *Approved Practices for Dairy* (VAS Approved Practices #A200). Vocational Agriculture Service, College of Agriculture, University of Illinois, 1401 S. Maryland Drive, Urbana, IL 61801. (217) 333-3871.

11. *Livestock, Dairy and Poultry Production* (Subject Matter Unit #8642A); *Performing Common Immunization Skills* (Subject Matter Unit #8645E. Instructional Materials Service, Texas A & M University, P.O. Box 2588, College Station, TX 77843-2588.

*12. *Animal Welfare.* (#75117). RMI Media Productions, 2807 West 47th Street, Shawnee Mission, KS 66205.

*Indicates highly recommended reference

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTIONAL RESOURCES

These resources are intended for use by teachers in planning and teaching the materials for this problem area and may be adapted to fit the teaching method(s) used.

INFORMATION SHEET #1 — Forms of Medications

TRANSPARENCY MASTER #1 — Signs of Good Health (with discussion guide)

TRANSPARENCY MASTER #2 — Normal Temperature, Pulse Rate, and Breathing Rate of Farm Animals (with discussion guide)

TRANSPARENCY MASTER #3 — Sheep Health Checklist (with discussion guide)

TRANSPARENCY MASTER #4 — Beef Cattle Health Checklist (with discussion guide)

TRANSPARENCY MASTER #5 — Swine Health Checklist (with discussion guide)

TRANSPARENCY MASTER #6 — Horse Health Checklist (with discussion guide)

TRANSPARENCY MASTER #7 — Dairy Cattle Health Checklist (with discussion guide)

TRANSPARENCY MASTER #8 — Approved Practices for Handling Medications (with discussion guide)

TRANSPARENCY MASTER #9 — Kinds of Medicinal Applications, Injections, and Equipment (with discussion guide)

TRANSPARENCY MASTER #10 — Kinds of Medicinal Applications, Injections, and Equipment (with discussion guide)

TRANSPARENCY MASTER #11 — Vaccinating Equipment (with discussion guide)

TRANSPARENCY MASTER #12 — Vaccinating Equipment (with discussion guide)

TRANSPARENCY MASTER #13 — Intravenous Setup and Thermometer (with discussion guide)

TRANSPARENCY MASTER #14 — Eyedropper, Trocar and Cannula, Dose Syringe (with discussion guide)

TRANSPARENCY MASTER #15 — Endotracheal Tube and Forceps (with discussion guide)

TRANSPARENCY MASTER #16 — Stomach Tube and Balling Gun (with discussion guide)

TRANSPARENCY MASTER #17 — Cattle Oiler

TRANSPARENCY MASTER #18 — Locations and Types of Hypodermics Injections for Cattle (with discussion guide)

TRANSPARENCY MASTER #19 — Locations and Types of Hypodermic Injections for Swine (with discussion guide)

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INFORMATION SHEET #1

Forms of Medication

Oral forms include:

1. Those given in feed.
2. Those given in water.
3. Those given in pill form.

Injectable forms include:

1. Those that may be administered with a syringe.

Other forms include:

1. Those that can be used as a spray.
2. Those that can be used as dusts.
3. Those that can be used as a dip.
4. Those that can be used as a drench.
5. Those that are used as salves or ointments.

TRANSPARENCY MASTER #1

Signs of Good Health

Alertness

Bright eyes

Contentment

Eating with relish

Normal feces and urine

Normal temperature, pulse rate, and breathing rate

Sleek coat with pliable and elastic skin

TRANSPARENCY MASTER #2

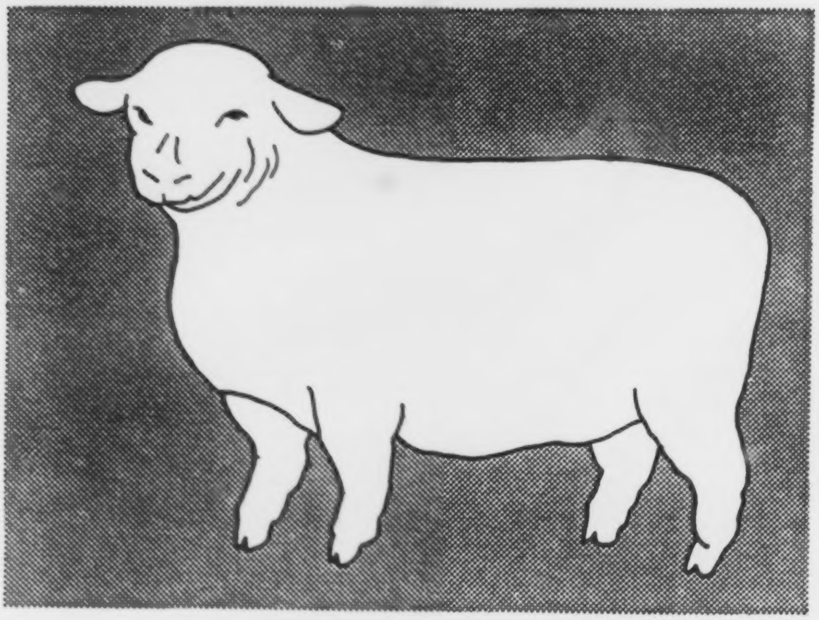
Normal Temperature, Pulse Rate, and Breathing Rate of Farm Animals

Animal	Rectal Temperature °F	Pulse Rate beats/min	Breathing Rate breaths/min
Cattle	101.5	60 - 70	10 - 30
Sheep	102.3	70 - 80	12 - 20
Goats	103.8	70 - 80	12 - 20
Swine	102.6	60 - 80	8 - 13
Horses	100.5	32 - 44	8 - 16
Poultry	106.0	200 - 400	15 - 36

TRANSPARENCY MASTER #3

Sheep Health Checklist

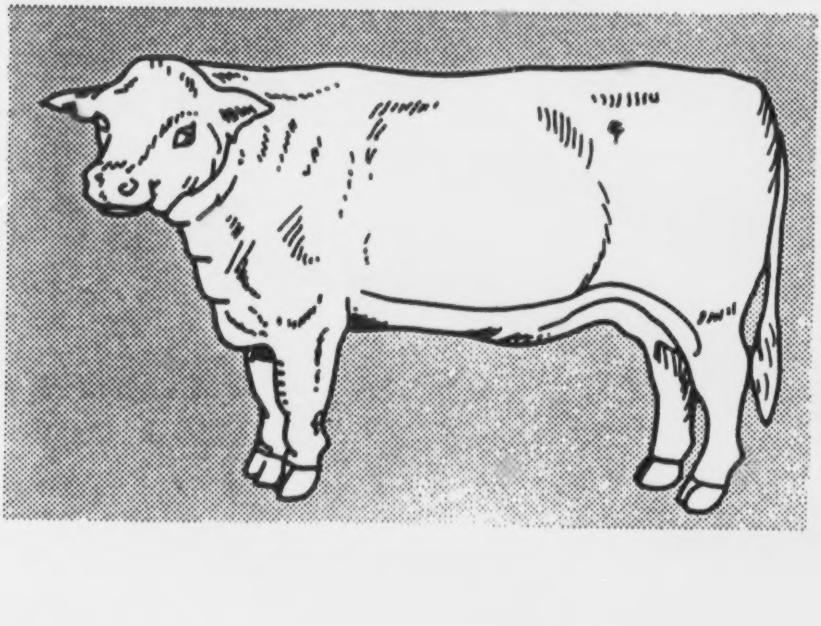
1. Pasture rotation
2. Parasite control
3. Vaccinations
4. Sanitation
5. Isolation of new animals



TRANSPARENCY MASTER #4

Beef Cattle Health Checklist

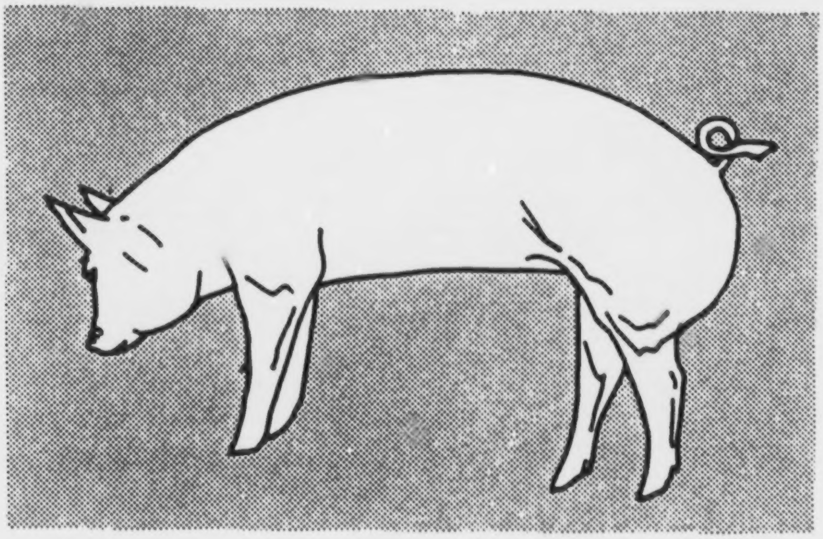
1. Healthy parents
2. Parasite control
3. Vaccinations
4. Maternity stalls
5. Isolation of new animals



TRANSPARENCY MASTER #5

Swine Health Checklist

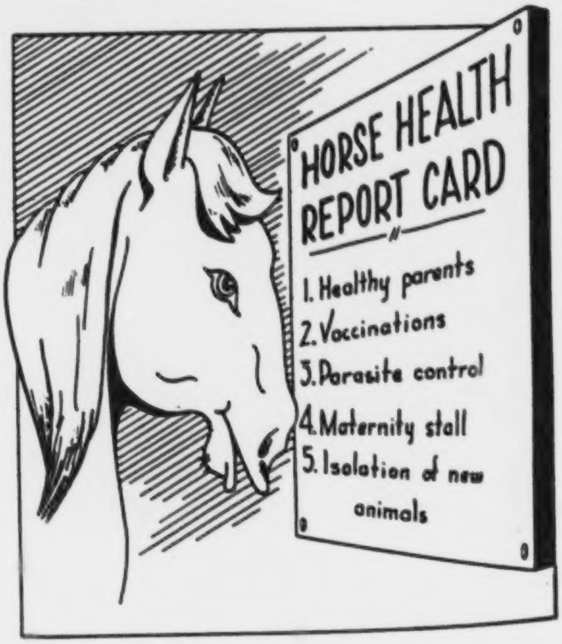
1. Housing and equipment
2. Vaccinations
3. Parasite control
4. Isolation of new animals
5. Observation



TRANSPARENCY MASTER #6

Horse Health Checklist

1. Healthy parents
2. Vaccinations
3. Parasite control
4. Maternity stall
5. Isolation of new animals


HORSE HEALTH REPORT CARD
1. Healthy parents
2. Vaccinations
3. Parasite control
4. Maternity stall
5. Isolation of new animals

TRANSPARENCY MASTER #7

Dairy Cattle Health Checklist

1. Milk production record
2. Reproductive record
3. Mastitis screening test
4. Blood tests
5. Vaccinations
6. Parasite control
7. Isolation

DAIRY CATTLE HEALTH
REPORT CARD

1. Milk production record
2. Reproductive record
3. Mastitis screening test
4. Blood tests
5. Vaccinations
6. Parasite control
7. Isolation

TRANSPARENCY MASTER #8

Approved Practices for Handling Medications

1. Products should be protected from heat and light and refrigerated at 35° - 45°F.
2. Vacuum - dried vaccines should be used immediately.
3. Animals should be properly restrained before administering medication.
4. Product should be used when opened to prevent contamination.
5. Always use sterilized instruments.
6. Uniformed suspensions may be obtained by shaking the vaccine.
7. Always use recommended dosages.
8. Do not attempt to immunize diseased or unhealthy animals.
9. Always read instructions carefully.
10. Always keep out of reach of children and animals.

TRANSPARENCY MASTER #9

Kinds of Medicinal Applications, Injections, and Equipment

1. **Paraexternal**
   The material is applied or injected anywhere other than into the intestinal tract.

2. **Cutaneous**
   The material is applied to the skin or rubbed into the skin.

3. **Intracutaneous or Intradermal**
   The material is injected into the skin.

4. **Subcutaneous**
   The material is injected just under the skin.

5. **Intravenous**
   The material is injected into a vein when fast action is wanted.

6. **Intramuscular**
   The material is injected into muscle tissue, commonly into muscles in the neck or thigh.

7. **Intracardial**
   The material is injected directly into the heart.

8. **Intrathoracic**
   The material is injected into the thorax. This is not commonly used.

9. **Intraocular**
   An injection is made under the eyelid, into the cornea, or into the anterior chamber.

TRANSPARENCY MASTER #10

Kinds of Medicinal Applications, Injections, and Equipment (con't)

10. **Epidural**
An injection is made directly into the spinal canal.

11. **Intrapulmonary**
The material is injected into the lung.

12. **Inhalation**
Vapor or dust is inhaled.

13. **Oral**
The material is taken by mouth or injected through a stomach tube.

14. **Rectal (Enema)**
The material is injected into the rectum.

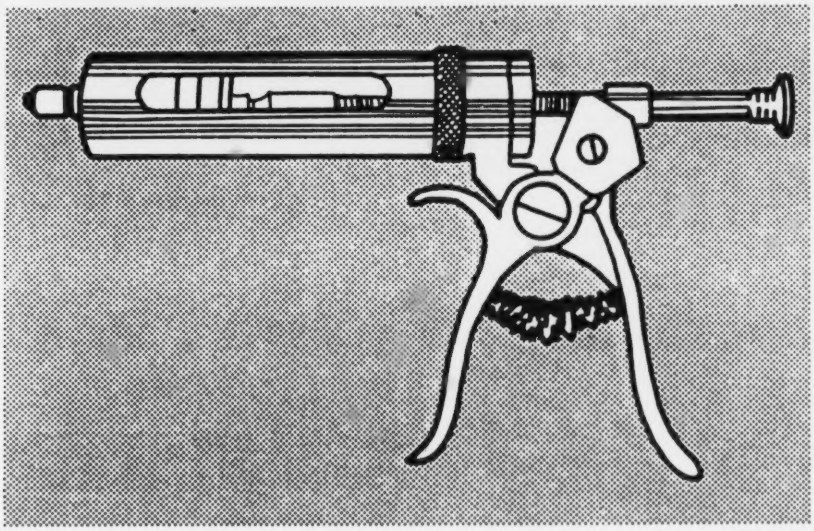
15. **Intramammary**
The material is injected into the mammary gland.

16. **Syringe**
A syringe is an instrument used to make injections, consisting of plunger, barrel and various types and sizes of needles.

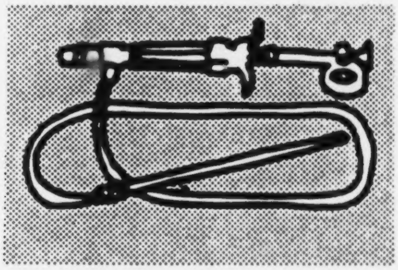
17. **Stomach Tube**
A stomach tube is used to pass materials directly into the stomach. It may be inserted through the mouth or nostril.

TRANSPARENCY MASTER #11

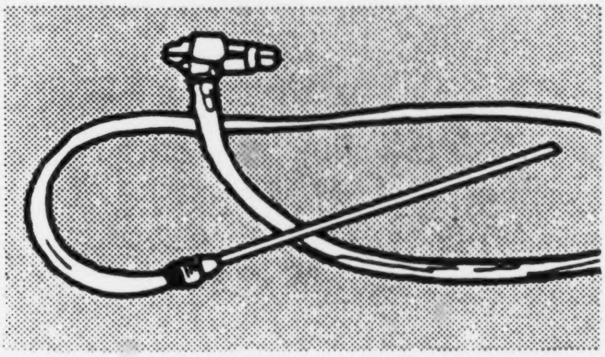
Vaccinating Equipment



Automatic repeat (pistol grip) syringe



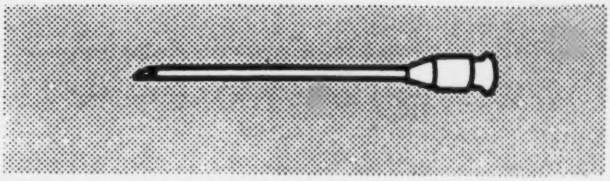
Self-filling automatic syringe (pump type)



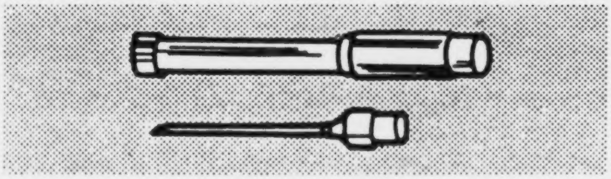
Syringe filler attachment

TRANSPARENCY MASTER #12

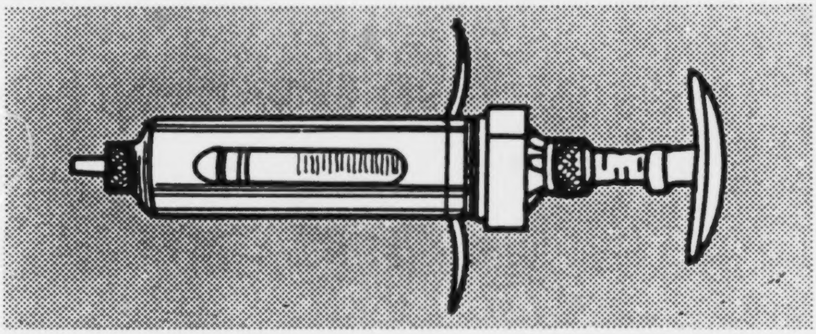
Vaccinating Equipment



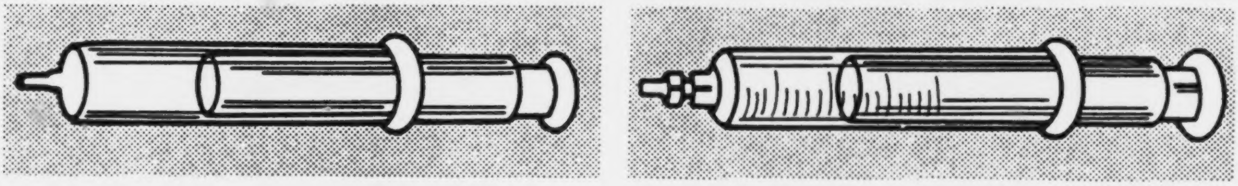
Reusable stainless



Disposable sterile

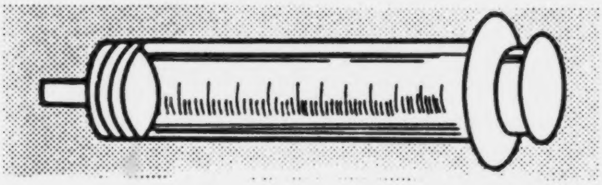


Standard metal syringe with glass barrel



With plain or metal tip with luer lock tip

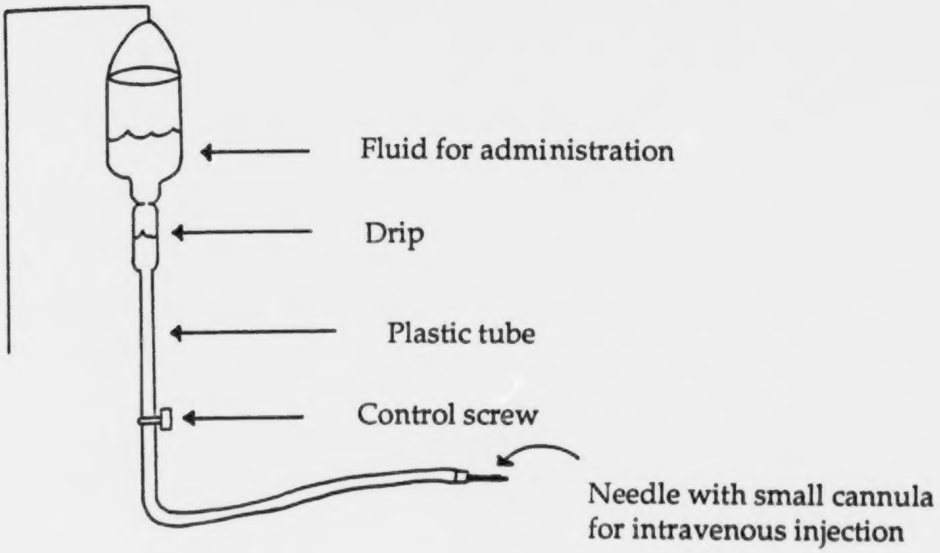
Reusable glass or nylon syringes



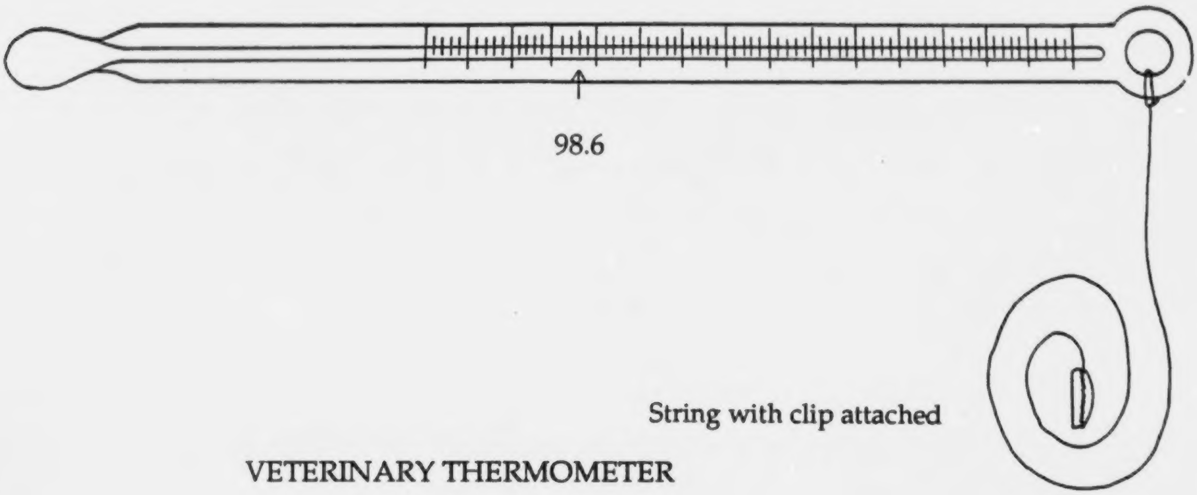
Disposable plastic syringe

TRANSPARENCY MASTER #13

Intravenous Setup and Thermometer


Fluid for administration
Drip
Plastic tube
Control screw
Needle with small cannula for intravenous injection

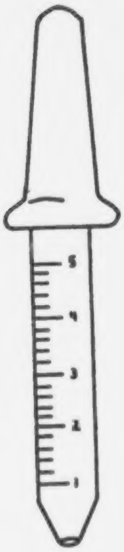
INTRAVENOUS SET UP

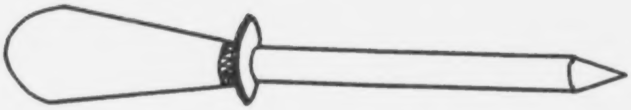

98.6
String with clip attached

VETERINARY THERMOMETER

TRANSPARENCY MASTER #14

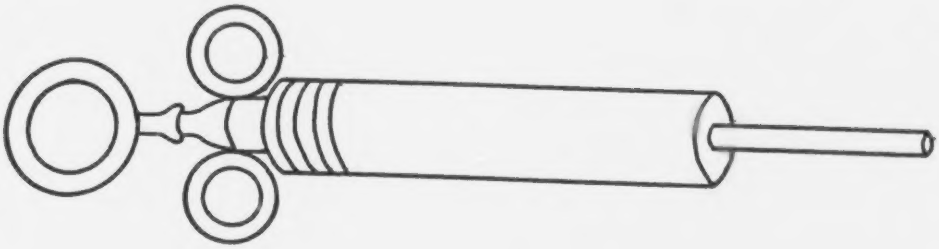
Eyedropper, Trocar and Cannula, and Dose Syringe





TROCAR AND CANNULA

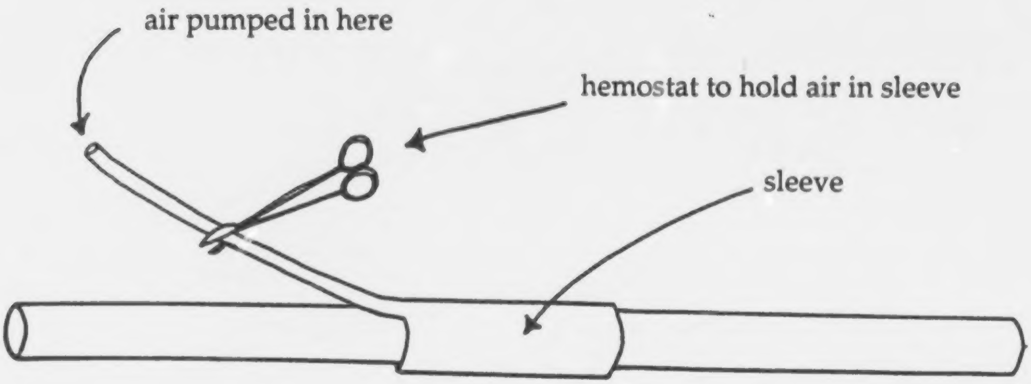
CALIBRATED EYEDROPPER



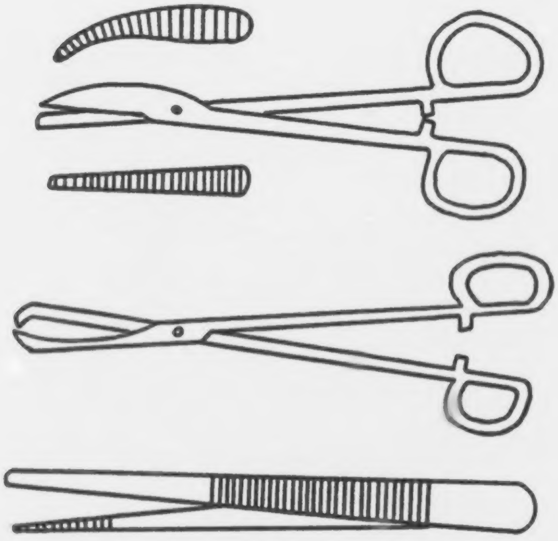
THREE RING METAL DOSE SYRINGE

TRANSPARENCY MASTER #15

Endotracheal Tube and Forceps


air pumped in here
hemostat to hold air in sleeve
sleeve

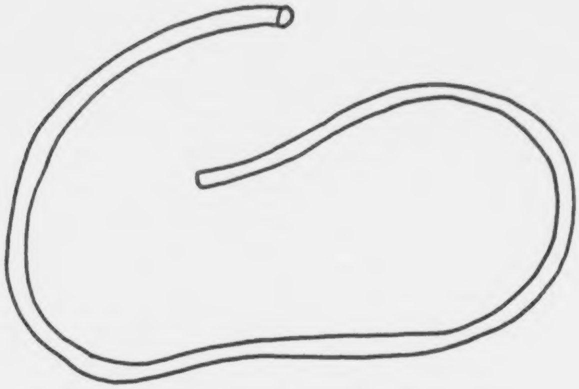
ENDOTRACHEAL TUBE



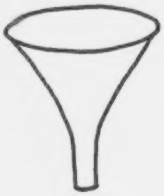
FORCEPS

TRANSPARENCY MASTER #16

Stomach Tube and Balling Gun

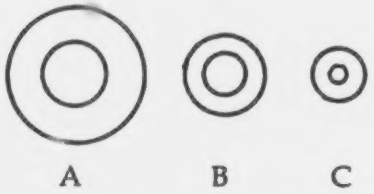


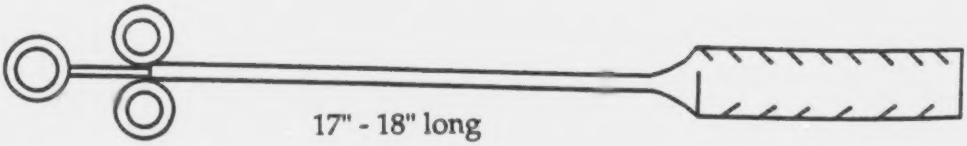
STOMACH TUBE



FUNNEL

Sizes:

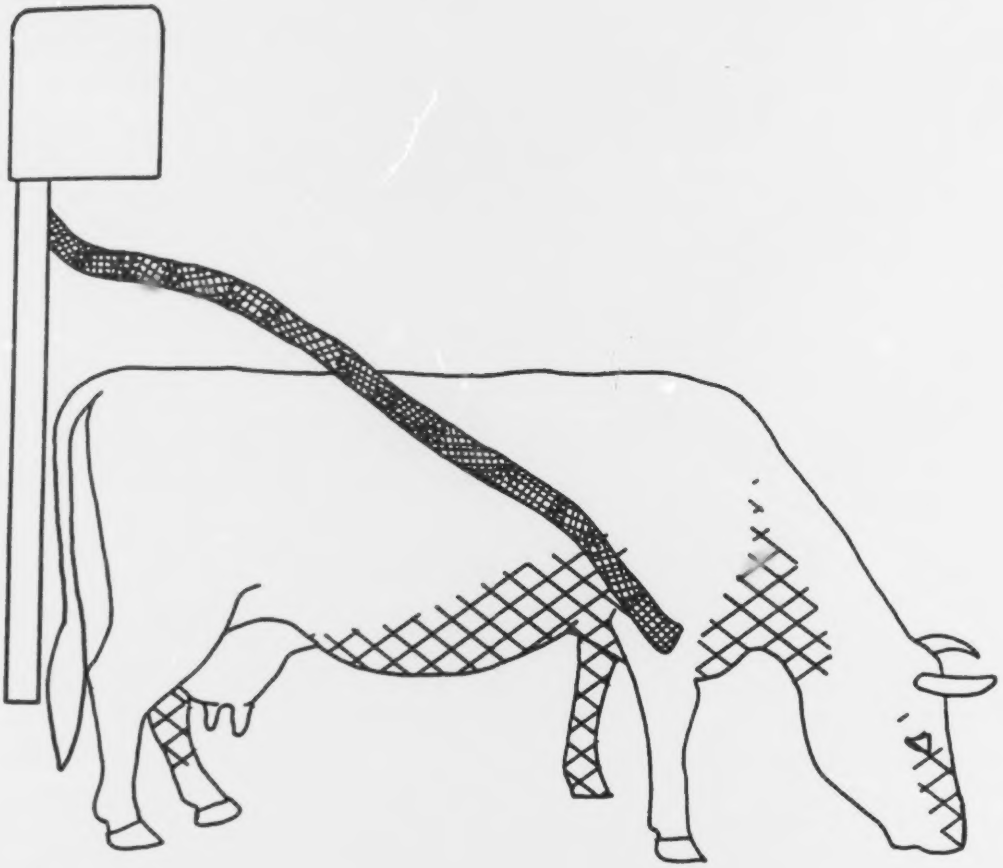




BALLING GUN

TRANSPARENCY MASTER #17

Cattle Oiler



Cattle Oiler

Allows cattle to rub flies and other parasites off and to spread oil from cable onto surface of skin.

Check contents of vat at top periodically.

TRANSPARENCY MASTER #18

Locations and Types of Hypodermic Injections for Cattle

A. Intramuscular

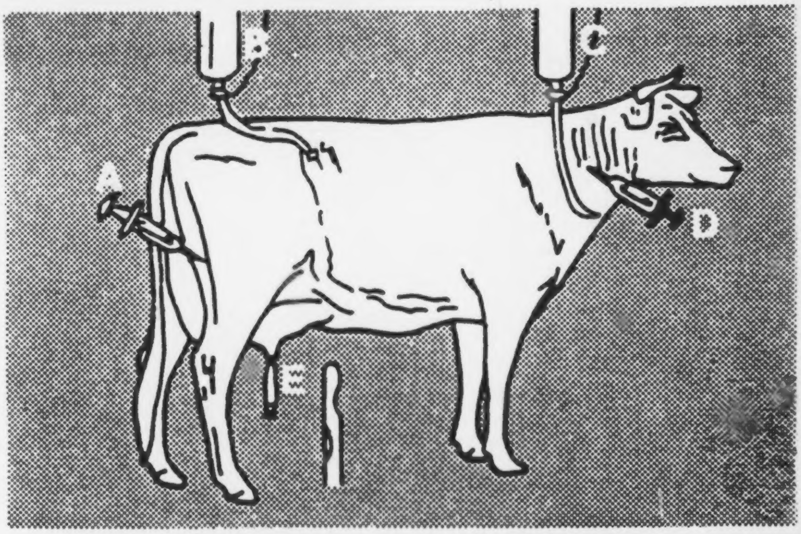
B. Intraperitoneal

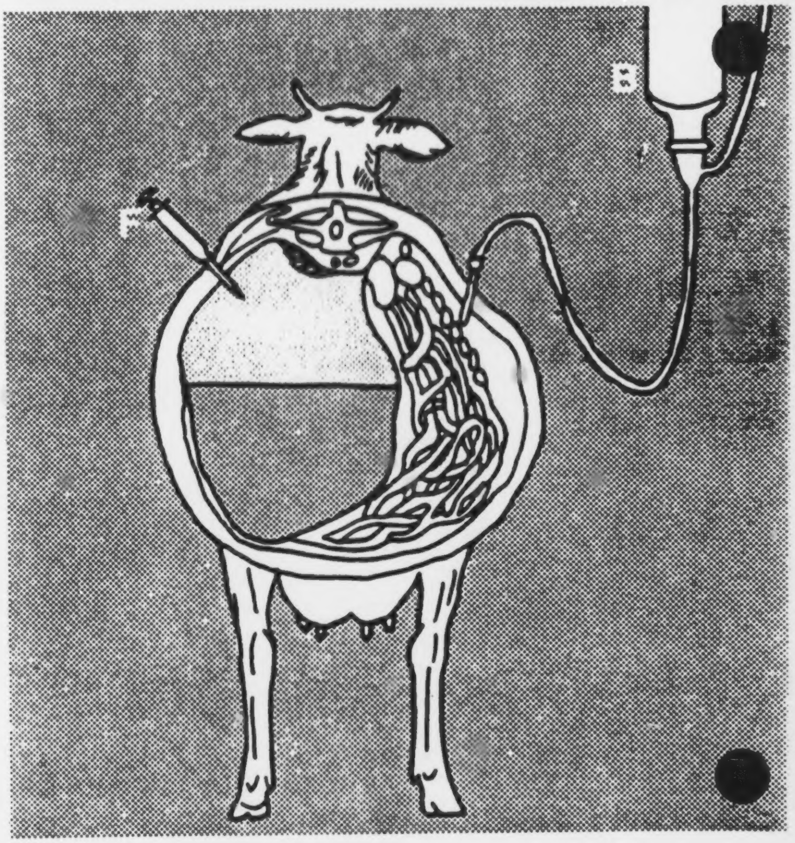
C. Intravenous

D. Subcutaneous

E. Intramammary

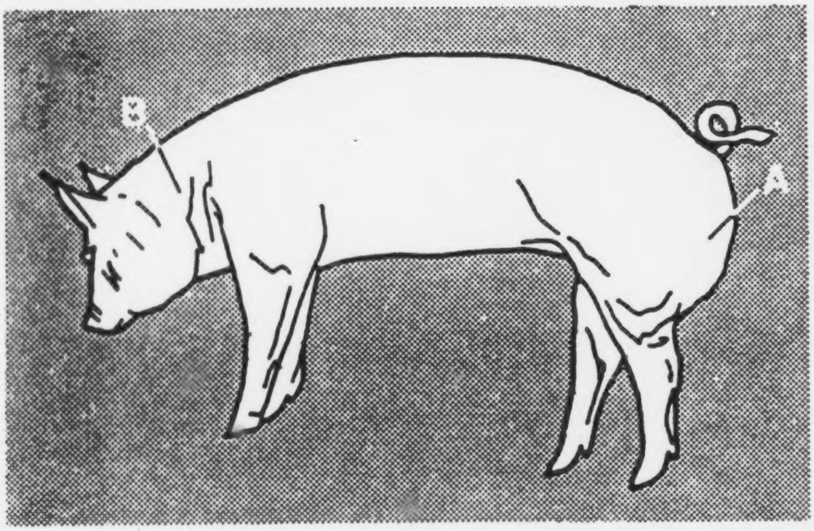
F. Intrarumenal

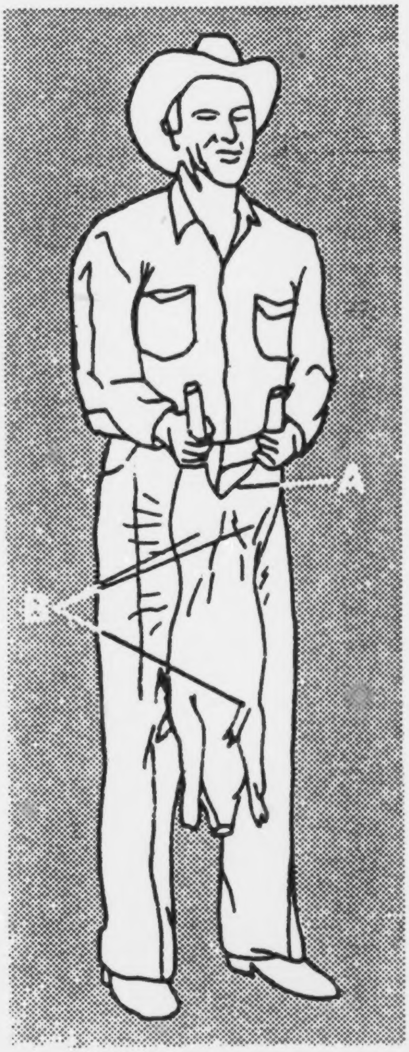




TRANSPARENCY MASTER #19

Locations and Types of Hypodermic Injections for Swine





A. Intramuscular

B. Subcutaneous

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TRANSPARENCY MASTER DISCUSSION GUIDE

Transparency Master #1

1. Discuss the ways of looking for these signs in different species of animals.
2. Have the students decide when the absence of any of these signs would require the advice of a veterinarian.

Transparency Master #2

1. Go over all the rates for different species.
2. Discuss how to check these rates, and have students relate any experiences they might have had in making these checks.

Transparency Masters #3 - #7

1. Ask students, whose families raise the different species, to explain what they do to maintain their livestock herds.
2. Go over the factors for each of the species and explain them to students.
3. Compile a list of approved health activities for all of the species.

Transparency Master #8

1. Go over each of the ten practices, and explain why these should be followed.
2. Have students explain the consequences if they are not followed.

Transparency Masters #9 and #10

1. Discuss the various methods of injecting and applying medications.
2. Ask the students if they have used any of these methods, and what were some of the problems they encountered when using them.
3. Refer to Transparency Masters #11 and #12 for the most common types of equipment used by stockmen.

Transparency Masters #11 and #12

Use
1. Ask students to identify in what way the vaccinating equipment would be used.
2. Discuss the advantages and disadvantages of each of the types of equipment.
3. Describe which medications would work best for the different types of equipment.

Care
1. Disassemble for complete cleaning.
2. Rinse under tap with brush and disinfectant.
3. Boiling and autoclaving may cause rubber plungers to dry and crack. These can be lubricated with oil.
4. Autoclave or boil to sterilize.
5. Store in a dry place.

Transparency Master #13

Intravenous Set Up

Use
1. Dispose of equipment after use.

Care
1. Fluids are administered into the vein over an extended period of time. (This equipment may also be used subcutaneously).
2. The needle and cannula are injected intravenously; the needle is removed and the plastic tube is attached to the cannula.
3. Liquid should be run down through the tube before attaching so that no air gets into the vein.
4. Adjust drip with control screw until desired rate of flow is obtained.
5. Keep animal still.

Thermometer

Use
1. Clean with alcohol.
2. Shake down to 98°F.
3. Insert in rectum after lubrication.
4. Attach clip to tail of large animal.
5. After 3 minutes, remove and read carefully.

Care
1. Never clean under faucet; hot water will break thermometer.
2. Swab with cotton soaked in disinfectant or alcohol.
3. Store in protective case at room temperature.

Transparency Master #14

Eyedropper

Use
1. Fill by squeezing out all air and inserting into liquid.
2. Hold with opening down and read amount. Adjust as necessary.

Care
1. Do not boil or autoclave; rinse with disinfectant.
2. Discard and replace cracked or dried tops.
3. Store in dry place.

Trocar — daggerlike, sharply pointed rod; contained in the cannula in such a manner that the sharp point projects freely from one end.

Use
1. To relieve bloat in ruminants the trocar and cannula are inserted into the rumen. The trocar is removed leaving in place the cannula, through which gas escapes.

2. Smaller versions may be used in udder infusion in dairy cows.

Care

1. Rinse under faucet, using antiseptic solution and brush.
2. Autoclave or boil to sterilize.
3. Store in a dry place.

Dose Syringe — used for oral administration of medicine to animals; made mostly from metal; capacity marked in fluid ounces.

Transparency Master #15

Endotracheal Tube

Use

1. Insert through the mouth to the trachea after the animal is under anesthetic.
2. Anesthetic or oxygen may be administered to the animal by attaching the tube to tanks.
3. Air is pumped into the sleeve to enlarge it so that it fits the trachea.

Care

1. Rinse in disinfectant.
2. Do not boil or autoclave.
3. Store in dry place.

Forceps

Types

1. Hemostatic Forceps — has large serrations to insure positive grip.
2. Vulsellum Forceps — has rounded prongs to insure firm grasp.
3. Tissue Forceps — has serrated point.

Use

1. Holds tissues aside during surgical procedures.
2. Clamps veins or arteries closed during surgery.
3. Removes small foreign particles from the body.

Care

1. Clean under faucet with stiff brush and disinfectant.
2. Dry and store in a dry, clean place.
3. Disinfect by boiling or autoclave for surgery.

Transparency Master #16

Stomach Tube

Use

1. The tube is lubricated and passed through nose, down the esophagus, and into the stomach.
    a. For mature cattle and horses, use a tube with 3/4" - 1 1/2" outside diameter and 3/8" lumen diameter.
    b. For colts, use a tube with 7/16" outside diameter and 1/4" lumen diameter.
    c. A typical tube has a 5/16" outside diameter and a 3/8" lumen diameter.
    d. A typical tube is 10 feet long.
2. Medication is poured into the tube through a funnel or pumped in by way of a dose syringe.

Care

1. To keep soft and pliable, must never boil or autoclave.
2. Store at room temperature after thorough rinsing with antiseptic solution.

Balling Gun

Use

1. Animal must be well restrained.
2. Gun with bolus is placed far back into animal's throat; bolus released into esophagus.

Care

1. Autoclave or boil if desired.
2. Generally, rinsing in disinfectant is sufficient.
3. Dry, store in dry place.

Transparency Masters #18 and #19

1. Review each of the various types of injections with students.
2. Have students discuss why certain medications need to be administered in different places.
3. Give some examples to students of medications that would be used with the various types of injections.
4. Injections of various medicinal agents are commonly administered by stockmen. Such injections are a convenient and accurate means of treating sick animals or administering vaccines, serums, and bacterins.
5. Types of injections:
    a. Subcutaneous Injection (Sub Q) — may be made in any area over which the skin fits loosely such as the neck, chest wall, "armpit," or flank. A small area is cleansed with alcohol and the needle inserted through the skin and the syringe contents discharged. A fold of skin may be picked up to facilitate entry of the needle. Following the injection, the area may be massaged to facilitate distribution.
    b. Intramuscular Injection (IM) — should be made deeply into a large muscle (thigh, shoulder, or neck). Cleanse an area as outlined above and insert the needle deeply into the muscle. Use a needle at least •" in length for cattle, sheep, and swine.
    c. Intraperitoneal Injection (IP) — is used mainly for the administration of large quantities of fluid such as Calcium Gluconate, Dextrose, Triple Sulfa, etc., for cattle. Use a long needle — 16 gauge x 2" or 14 gauge x 3". Warm the solution to body temperature prior to administration. Insert the needle into the right flank at a point in the center of the triangle formed by the loin, last rib, and a line from the top of the last rib to the hip bone. Use sterile precautions.

d. Intrarumenal Injection (IR) - is used to administer medication promptly in bloat. Always insert needle through LEFT flank. Use 14 gauge x 3" needle. Proper position of needle is noted by return through the needle of gas or liquid from the stomach. This is a rarely used procedure.

e. Intradermal Injection (ID) — should be made with a 20 - 26 gauge needle into the skin. Proof of successful intradermal injection is the raising of a blister consisting of ingredient injected. Hair should be shaved previous to injection.

f. Intramammary Injection (IMM) — can be accomplished by disinfecting the teat; depressing the teat to open the sphincter muscle, inserting the sterile cannula, and forcing the medication into the teat canal from the syringe or tube. Disinfect the teat after infusion.

g. Intravenous Injection (IV) — should be made into a vein, most commonly one of the jugular veins. These veins are located on either side of the neck. They are located in a groove running from behind the jaw bone to the shoulder. To perform the injection, apply pressure to the vein by thumb or tourniquet. This cuts off the blood flow and enlarges the vein to a visible size. Disinfect and insert needle through the skin into the vein. Once into the vein, the needle should be directed upward toward the head. Always check for blood flow before attaching the intravenous tube and allowing medication to enter blood stream. The flow of product should be slow.

STUDENT ACTIVITIES

STUDENT WORKSHEET #1 — Proper Care and Filling of Syringes for Livestock Laboratory Exercise

STUDENT WORKSHEET #2 — Animal Diseases and Parasites

STUDENT WORKSHEET #3 — Health Equipment Demonstration

STUDENT WORKSHEET #4 — Medication Inventory

For additional activities, teachers may refer to the "Suggested Teaching Activities and Procedures" section in the Instructor's Guide.

STUDENT WORKSHEET #1

Proper Care and Filling of Syringes for Livestock Laboratory Exercise

Purpose:

1. To understand the different types of syringes used on livestock.
2. To develop the necessary skills for filling a syringe correctly.
3. To properly clean and store syringes.

Materials:

1. assorted mixture of syringes
2. pan with cool water
3. stove or hot plate
4. bottles of medications
5. alcohol and cotton
6. an orange

Procedure:

1. Identify the different types of syringes to students.
2. Demonstrate the placing of metal and glass syringes into boiling water to sterilize them.
3. Demonstrate with alcohol how to clean plastic syringes.
4. Demonstrate how to properly fill a syringe with medication, and remove all air from the syringe.
5. Allow students to fill syringes.
6. Have students sterilize a spot on the orange and make an injection.
7. If possible have students make injections into real animals.
8. Have students properly sterilize the needles and syringes and put them away for future use.

Questions:

1. Why is it important that the syringes be sterilized?
2. Why is it important that all air bubbles be removed from the syringe before the injection?
3. How will this project make your livestock SAEP more efficient?

Observations:

1. How far does one insert the needle for different types of injections?
2. How does practicing on an orange help prepare you for an actual injection in an animal?

Conclusions:

1. How secure do you feel about giving injections?
2. Do you feel confident about the different types of injections and where they are given?

STUDENT WORKSHEETS #2

Animal Diseases and Parasites

Complete the following table for specifc diseases as assigned by your instructor. Your instructor may allow you to choose a specific animal species. You may then concentrate on studying the diseases affecting that species. References will be provided.

Disease	Symptoms	Prevention/Treatment

STUDENT WORKSHEET #2 — Key

Animal Diseases and Parasites

Swine Diseases*

Disease	Symptoms	Prevention/Treatment
Atrophic Rhinitis	Persistent sneezing, which worsens as pigs get older. Snout begins to wrinkle at 4 - 8 weeks. At 8 - 16 weeks snout and face twist to one side. Pigs become rough looking and make small weight gains, with frequent nosebleeds. Pigs between 60 and 80 pounds are most susceptible.	Select breeding stock from herds free of rhinitis. Use clean farrowing quarters. Purchase feeder pigs above 60 - 80 pounds because they are less susceptible. Separate different age groups. Treat with sulfonamide drugs; the two most common ones are sulfamethiazine and sodium sulfathiazole.
Erysipelas	High fever; breathing with a snoring sound; purple patches under belly; edema of nose, ears, and limbs. When disease becomes chronic, knees and hocks are generally swollen and stiff.	Farms infected with disease should administer one of the following products: Erysipelas vaccine (available through vet), Erysipelas bacterin, or oral Erysipelas vaccine in the water. A serum given in conjunction with penicillin will provide satisfactory treatment.
Influenza	High fever, loss of appetite, coughing, discharge from eyes and nose. Animals are reluctant to move, but may sit up like dogs to help improve their breathing. Symptoms appear suddenly.	Use dry, clean hog lots that are rotated. Provide warm, dry, clean quarters and minimum rations. Antibiotics and sulfonamides may be used on a herd basis to control various bacterial invaders.
Leptospirosis	Abortions, pigs born dead or weak, unthrifty market hogs. Disease is spread by infected urine.	Vaccinate susceptible animals annually if disease is present in area. Purchase clean animals, isolate for 30 days. Treatment should be prescribed by vet. Usually includes administration of selected antibodies, and good care. Clean environment.
Parrovirus	Failure to breed, mummified pigs, small litters. Diagnosis of this reproductive disease can be made by testing the pigs.	Prevent by vaccinating the sows prior to breeding and building up a natural immunity in your herd.
Pneumonia	Chills, followed by elevated temperature; quick, shallow respiration; discharge from nostrils and eyes; coughing; loss of appetite; constipation; standing with legs wide apart; gasping for breath and crackling noises while breathing.	Provide clean, dry environment. Place sick animals in quiet clean quarters away from drafts, and provide easily digestible food. Sulfonamides and antibiotics are effective in treating acute pneumonia, but are not effective in viral pneumonia, except to keep down secondary bacterial pathogens.
Pseudorabies	Fever, dullness, loss of appetite, vomiting, weakness, incoordination, and convulsions. Death rate among pigs younger than three weeks is very high. Among older pigs symptoms include fever, going off feed, coughing, sneezing, vomiting, diarrhea, constipation, convulsions, blindness. Sows may abort, or give birth to weak, shaken or stillborn pigs.	Vaccine is available, but state authorities must authorize vaccine usage. Breeding stock are vaccinated twice per year, prior to breeding. Vaccinate pigs after 3 days old if from unvaccinated sow. Keep area clean and sanitary, and try to avoid contact with people and animals that may carry disease away from herd.

Swine Dysentry	Profuse bloody diarrhea, black feces that contains shreds of tissue, moderate rise in temperature, animals going off feed. Pigs usually die.	Isolate new animals, and practice rigid sanitation. Medication through drinking water is essential. Antibiotics may be given by vet. Good management is the best prevention.
Salmonellosis	Going off feed, listless, scouring. This acute enteritis is usually fatal.	Sick animals should be moved off by themselves and treated with sulfa drugs, nitrofuraus, or antibiotics, after consultation with your vet. Pigs should be posted to identify which type of bacteria is causing the disease. Good sanitation and management is the only prevention for disease.
Swine Pox	Small red spots over large area of body, especially on ears, neck, and undersurface of body. A hard knot develops in each of the spots, and then blisters, drains, dries up, and scabs off. Some animals show fever, chills, and refusal to feed.	Control of lice, which transmit the disease, is the best prevention. Good management is essential.
Transmissible Gastroeneritis (TGE)	Scouring, vomiting, inflammation of the stomach and intestines. Disease spreads rapidly, and the entire herd may be affected in 2 - 3 days.	Most effective preventive measure consists in exposing sows to the disease before they farrow. The sows will develop a resistance and piglets will get the antibodies from the milk, make sure there is no danger with other animals on farm, and other farms. No effective treatment, good feeding and management the best. Antibiotics or sulfonamides may minimize secondary bacterial complications.

Sheep Diseases*

Disease	Symptoms	Prevention/Treatment
Enteroloxemia (Overeating Disease)	Loss of appetite, sluggishness, diarrhea, staggering, and convulsions. Animals usually die within a few hours. Disease affects sheep of all ages in a high state of nutrition — on a lush feed grain, milk or grass.	Make a gradual change from range to feedlot. Vaccinate lambs with either a bacterin or toxoid soon after their arrival in feedlot, can vaccinate pregnant ewes to prevent young lamb losses. No successful treatment.
Foot Rot	Lameness, reddening and swelling of the skin just above the hoof, between the toes, or on bulb of heel. Animal may show fever, depression, loss of weight, and may die.	Drain muddy pastures. Purchase stock from a clean source. Allow land previously pastured by sheep to remain idle 4 weeks before turning other sheep on it. To treat, examine feet of sheep and trim feet showing infection. Walk sheep through suitable disinfectant solution and move to clean ground. Most widely used disinfectants are formaldehyde and copper sulfate. Repeat until foot rot disappears.
Listerellosis (Circling Disease)	Depression, staggering, circling, and strange awkward movements. Diagnosis can be made only by lab examination of the brain.	A good way to prevent is to follow this program. Do not store silage in a silo in poor repair. Do not feed the top layer of an upright silo. Never feed moldy silage. Provide clean, dry quarters and clean water, control parasites, and avoid stress. Treat with sulfa derivatives, alone and in combination with antibiotics.

Mastitis (Blue Bag)	Hot and painful udder in early stages, secretion from teats, rise in temperature; if untreated, chronic discharging teats, gangrene, and death.	Antibiotics or sulfas are the treatments. Ewe should be sold after udder has healed.
Pregnancy Disease (Ketosis)	Grinding of teeth, dullness, weakness, frequent urination, trembling, complete collapse, and death in 90 percent of cases. This disease strikes during the last 2 weeks of pregnancy and usually affects ewes carrying twins or triplets.	Avoid obesity in early pregnancy. Feed liberally last 6 weeks of pregnancy. Give propylene glycol orally twice daily.
Sore Mouth	Refusal to eat, depression. Small cysts appear on the lips, gums and tongue, causing them to become red and swollen. These may break and bleed, and then form a scab; may become infected and may spread to the teats, udder, and feet of mother. Usually only lambs are affected.	General sanitation helps prevention. Vaccine will produce an immunity, uninfected sheep should not be vaccinated, because this will infect premises. Infected lips, mouths, and nostrils should be treated by applying an ointment containing a broad spectrum antibiotic to the lesions.
Tetanus (Lockjaw)	Stiffness around head; slow, weak chewing; awkward swallowing; inner eyelid protruding over eyeball. Diseae is associated with a wound. Noises cause spasms. Animals usually remain standing until death.	Immunity against tetanus can be obtained through inoculation with either a toxoid or an antitoxin. For treatment, place the animal under the care of a veterinarian and keep it quiet. Good nursing is important.
Urinary Calculi	Frequent attempts to urinate, dribbling, or stoppage of the urine. Usually only males are affected; females may pass obstruction. Bladder may rupture with death following; otherwise uremic poisoning may set in.	Good feed and management appear to lessen the incidence. Avoid high phosphorus and low calcium. Provide adequate vitamin A, salt, and water.
White Muscle Disease	Founderlike stiffness to sudden death. Whitish areas or streaks in the heart and other muscles can be observed during posting; selenium deficiency.	Use vitamin E in the feed according to directions. Vitamin E or selenium can be injected. Confine affected animals to a stall and give plenty of rest.

Beef and Dairy Diseases*

Disease	Symptoms	Prevention/Treatment
Anaplasmosis	Anemia, labored breathing, wasting away, straying from the herd, nervousness, death.	Feeding chlortetracycline helps prevention. A vaccine is available, but its use should be discussed with your vet. Also, intravenous injections of tetracyclines have helped in acutely ill animals.
Bovine Virus (BVD)	Fever, nasal discharge, rapid breathing, coughing, diarrhea, heavy eye discharge; later, elongated hooves, rough hair coat, loss of weight, and arched back.	Vaccine is available, but not highly successful in use. Calves should be vaccinated near weaning using combined vaccines.
Brucellosis (Bangs)	Abortions in the last third of pregnancy, retained afterbirth, several services per conception, and uterine infections.	Buy disease-free animals. Do not use calfhood vaccinations, unless there is a disease problem in the herd. There is no successful treatment.

Calf Scours	Depressed appearance; lack of appetite; softer-than-normal feces; severe diarrhea; yellowish, foul-smelling, watery, or foamy feces. Symptoms vary from mild to severe. Death usually follows 2 - 3 days after diarrhea occurs.	Live virus vaccine is 80 percent effective. Discontinue feeding milk for 24 - 48 hours and give fluids orally to combat infection. Treatment should be recommended by vet.
Infectious Bovine Rhinotracheitis (IBR) (Red Nose)	Going off feed, weight loss; coughing; pain in swallowing; slobbering; rapid breathing; inflammation of nostrils, trachea, and windpipe; fever. Symptoms last about 1 week.	Two types of vaccine are available. There is no known treatment, but sulfonamides and antibiotics effectively combat secondary bacterial infections.
Johne's Disease (Paratuberculosis)	Loss of flesh, intermittent diarrhea and constipation, watery feces. Symptoms may last for 2 years, but disease is almost always fatal. Autopsy reveals the thickening of the infected part of the intestine covered by a slimy discharge.	Keep the herd away from infected animals. Purchase disease-free animals from disease-free herds. No satisfactory treatment is known.
Leptospirosis	High fever, poor appetite, abortions, bloody urine, anemia, ropy milk.	Vaccinate susceptible animals annually. Purchase clean animals, isolate for 30 days, and retest. Treatment should be prescribed by vet, and may include blood transfusions, administration of antibiotics, and good care.
Mastitis	High temperature; hotness in affected quarter; hard or tender udder; lumpy and/or watery discharge with or instead of milk.	Prevention requires sanitation, washing teats with antiseptic solution before milking, proper milking, teat dipping after milking. Systemic treatment in acute cases includes intramammary injection of antibiotic. Treatment is more efficacious when causal organism is identified.
Pinkeye	Liberal flow of tears, tendency to keep eyes closed; redness and swelling of the lining membrane of the eyelids. Blindness will follow if left untreated.	Prevent by control of face flies, good nutrition, providing adequate vitamin A, and isolation of affected animals. Treat by applying twice daily antibiotics or sulfa drugs to the affected eye as ointments, powders, or sprays. Recovery is quickened by keeping affected animal in the dark.
Vibriosis	Abortions in middle third of pregnancy; several services per conception, and irregular heat periods. Diagnosis must be made by lab methods.	Vaccine is available — repeat annually. Avoid contact with diseased animals and contaminated feed and water. Artificial insemination is a rapid and practical method of stopping infection from cow to cow. Treatment involves injecting drugs into uterus, and allowing sexual rest.
Shipping Fever	High temperature, discharge from eyes and nose, a hacking cough, difficulty in breathing, and swelling in the region of the neck. Animals may die.	Eliminate as many factors as possible to reduce stress. Isolate newly acquired animals. Treatment should be handled by veterinarian.

Horse Diseases*

Disease	Symptoms	Prevention/Treatment
Distemper (Strangles)	Depression, loss of appetite, high fever, pus discharge from nose, enlarged glands at jaw, cough.	Avoid animals and equipment infected with bacteria. Quarantine animals, disinfect after recovery, burn or bury excretion and bedding. Vaccinate and provide yearly booster.
Equine Abortion	In first 2 months of pregnancy, no observable symptoms; in middle of pregnancy, typical abortion symptoms; in late pregnancy, abortion resembling normal parturition.	For infectious causes (virus, bacteria, fungi), prevent through normal sanitary cautions at breeding; for noninfectious causes (twinning, hormone, congenital), prevent through normal health and management practices; for all causes, prevent through vaccination and immunization, and good management of health and feed.
Equine Encephalomyelitis	Aimless walking, sleepiness and depression, local paralysis of throat, lips, bladder, blindness. Recovered animals may not normally react to stimulus.	Rapid course of disease makes the maintenance of fluids and electrolytes the best treatment. Vaccination against all three virus strains is necessary.
Equine Infectious Anemia (Swamp Fever)	High intermittent fever, weakness, unthriftiness, depression.	Prevent through good sanitation, disposal of hypodermic needles, and elimination of biting insects as far as practicable. There is no vaccine for specific causal virus. After a positive diagnosis (which is difficult), disposal of affected animals is suggested.
Equine Influenza	Rapid rising temperature (young horses most susceptible), loss of appetite, weakness, depression, dry cough, water, discharge from eye and nostrils followed by white- to yellow-colored nasal discharge.	Prevention includes minimizing changes in climate, stress during shipment, and fatigue; annual vaccination; and isolation of new animals. Treatment by vet is required to avoid secondary bacterial infection.
Glanders (Farcy)	Nasal discharge, hardened nodules that break down to ulcers, skin ulcers, cough followed by mucous discharge, sudden bleeding. These symptoms are observed in acute cases for mules and donkeys, and in chronic cases for horses.	Maintain sanitation and test exposed animals. There is no immunization. Destroy positively diagnosed animals.
Tetanus (Lockjaw)	Stiffness around head; slow, weak chewing; awkward swallowing; inner eyelid protruding over eyeball. Disease is associated with a wound. Noises cause spasms. Animals usually remain standing until death.	Immunity can be obtained through inoculation with toxoid or an antitoxin. Treatment by vet includes good nursing and keeping the animal quiet.

Parasites

Disease	Symptoms	Prevention/Treatment
Blowfly	Infected wounds, soiled hair; maggots spread over body. Infected animals rapidly become weak, fevered, and unthrifty.	Eliminate blowflys by destroying dead animals immediately. Once infected, wounds should be treated twice weekly with a smear, dust, or pressurized spray of the proper insecticide.
Lice	Intense irritation, restlessness, and loss of condition; severe itching; possible scratching, rubbing, and gnawing at the skin.	All members of herds must be treated simultaneously at intervals. Insecticides applied by spraying or dipping are most effective, but some control can be obtained by dusting.
Mites (Mange)	Marked irritation; itching and scratching; crusting over of the skin, accompanied by formation of thick, tough, wrinkled skin.	Avoid contact with diseased animals or infested premises. Control by spraying or dipping infested animals with suitable insecticides, and quarantine of affected herds.
Lungworm	Coughing, labored breathing, loss of appetite, unthriftiness, and intermittent diarrhea. Death may follow, probably from suffocation or pneumonia.	Practice rigid sanitation. Do not spread infected manure on pastures. Drench with a wormer effective against lungworms. Wormer should be given according to manufacturer's recommendations.
Ringworm	Round scaly areas almost devoid of hair appearing mainly in the vicinity of the eyes, ears, side of neck, or the root of the tail; mild itching.	Isolate infected animals. Disinfect everything that has been in contact with infected animals. Practice strict sanitation. Clip hair from affected areas and remove scabs with brush and mild soap. Put tincture of iodine on the affected areas.
Screwworm	Loss of appetite and condition, and lowered thrift and vigor.	Keep animal wounds to a minimum. Schedule branding, castrating, docking, and other stock operations that necessarily produce wounds during the winter months or early spring when flies are less active. Apply an insecticide to control.
Stomach Worms	Unthriftiness and marked loss of appetite.	Prevention consists in keeping young animals away from infection. Use compounds recommended for control of internal parasites, according to manufacturer's directions.

*Adapted from *The Stockman's Handbook.* M.E. Ensminger. 6th edition. Available from Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050 (217) 446-0500

STUDENT WORKSHEET #3

Health Equipment Demonstration

Name of Equipment ______________________________

Primary use ______________________________

Price ______________________________

List the step-by-step methods for properly using this equipment. ______________________________

____

____

List safety considerations and how the equipment is to be cleaned and stored. ______________________________

____

____

List the circumstances under which this equipment would be used. ______________________________

____

____

STUDENT WORKSHEET #4

Medication Inventory

Medication Name	Active Ingredient	Species	Administration Method	Restrictions

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Meeting the Environmental Requirements of Animals

RELATED PROBLEM AREAS:

1. Understanding the Animal Production Industry
2. Classifying Animals
3. Meeting Nutritional Needs of Animals
4. Understanding Animal Breeding and Reproduction
5. Maintaining Animal Health
6. Caring for Animals

PREREQUISITE PROBLEM AREA(S)

1. Identifying Basic Principles of Animal Science (Central Core Cluster)

LEVEL: Preparatory

OCCUPATIONAL TASKS ADDRESSED:

Agricultural Business and Management Cluster

Duty K: Maintaining and Constructing Structures

1. Plan building construction
2. Perform maintenance inspection of facilities

Duty N: Breeding, Handling, and Caring for Animals

1. Control building temperature
2. Control building ventilation
3. Control building lighting

Duty R: Applying Safety Practices

1. Correct safety hazards

STATE GOALS FOR LEARNING

In planning the instruction for this problem area, teachers can promote the development of several student learning objectives which are related to the State Goals for Learning in Biological and Physical Sciences and Social Sciences. These objectives are listed on the Learning Assessment Plan forms included on the following page(s). Those learning objectives marked with an asterisk (*) are taken from the sample lists provided by the Illinois State Board of Education.

Illinois Agricultural Core Curriculum

Agricultural Education 124 Mumford Hall 1301 W. Gregory Drive University of Illinois Urbana, IL 61801

Director: Dale A. Law, Ed.D.
Principal Investigator: Jerry D. Pepple, Ed.D.
Research Assistant: Robert E. Petrea

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ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date ____________________
☐ Original submission ☐ Revision
Page ____ of ____

(Affix label or complete district information.)

COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐

District Name

City

I. LEARNING AREA *(check one)*

☐ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☒ Sciences ☐ Physical Development/Health

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will have a working knowledge of the concepts and basic vocabulary of biological, physical, and environmental sciences and their application to life and work in contemporary technological society.

Contact Person: ____________________
Title: ____________________
Phone: ( )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Know the principle environmental factors that limit the distribution of plants and animals.					
2. Identify the components of an animal's environment and describe alternatives that provide those components.					
3. Define terms integral to meeting the environmental requirements of animals.					

ISBE 41-78 (1/86)

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

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Submission Date ____________________
☐ Original submission ☐ Revision
Page _____ of _____

I. LEARNING AREA *(check one)*
☐ Language Arts
☐ Mathematics
☒ Sciences
☐ Fine Arts
☐ Social Sciences
☐ Physical Development/Health

(Affix label or complete district information.)

COUNTY	DISTRICT	ESC

District Name
City

Contact Person: ____________________
Title: ____________________
Phone: (   )

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will have a working knowledge of the social and environmental implications and limitations of technological development.

III. LEARNING OBJECTIVES

By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:

III. LEARNING OBJECTIVES	IV. ASSESSMENT A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	V. EXPECTATIONS Percent of Students Expected to Achieve Objective
*1. Identify situations in which moral and ethical beliefs have affected the application of science.					
*2. Know how scientific inquiry is influenced by beliefs, traditions, views, and actions of society.					
*3. Understand how scientific and technological endeavors involve cooperation among individuals and groups.					
4. Relate the concerns of animal rights organizations to animal production.					
5. Compose arguments that illustrate the advantages of confinement production techniques to animals and consumers.					
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					633

ISBE 41-78 (1/88)

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

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Submission Date ____________________

☐ Original submission ☐ Revision

Page ____ of ____

I. LEARNING AREA *(check one)*

☐ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☒ Sciences ☐ Physical Development/Health

(Affix label or complete district information.)

COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐

District Name

City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will have a working knowledge of the principles of scientific research and their application in simple research projects.

Contact Person: ____________________
Title: ____________________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Relate alternatives to using animals in scientific research.					
2. Relate the concerns of animal rights organizations to animal production.					
3. Compose arguments that illustrate the advantages of confinement production techniques to animals and consumers.					
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ISBE 41-78 (1/88)

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LEARNING ASSESSMENT PLAN

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Submission Date ____________
☐ Original submission ☐ Revision
Page ____ of ____

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☐ Mathematics ☒ Social Sciences
☐ Sciences ☐ Physical Development/Health

(Affix label or complete district information.)
COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐
District Name
City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to apply the skills and knowledge gained in the social sciences to decision making in life situations.

Contact Person: ____________
Title: ____________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Evaluate the costs and benefits of a particular course of action.					
*2. Compare the economic interdependence among agriculture, business, government, labor, and the consumer.					
*3. Understand how individuals and/or groups effect change.					
*4. Understand the knowledge and skills required for success in selected fields of work.					
5. Relate the concerns of animal rights organizations to animal production management techniques.					
6. Compose arguments that illustrate the advantages of confinement.					
7. Identify the components of an animal's environment and describe different methods of providing these components.					
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ISBE 41-78 (1/86)

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Meeting the Environmental Requirements of Animals

STUDENT LEARNING OBJECTIVES

Upon completion of their study of this problem area, students will be able to:

1. Define terms integral to meeting the environmental requirements of animals.
2. Identify the components of an animal's environment and describe different methods of providing those components.
3. Explain the advantages and disadvantages of various animal handling systems.
4. Determine the space requirements for the various species of animals in selected stages of production.
5. Relate the concerns of animal rights organizations to animal production management techniques.
6. Compose arguments that illustrate the advantages of confinement production techniques to animals and consumers.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Meeting the Environmental Requirements of Animals

PROBLEMS AND QUESTIONS FOR STUDY

INSTRUCTOR'S NOTES AND REFERENCES

1. What are the methods of raising animals?
2. What are the advantages and disadvantages of each method of raising animals?
3. What are the environmental factors necessary for raising animals?
4. Why is it necessary for one to provide a proper environment for animals?
5. What are factors to be considered when locating animal facilities?
6. What are the space requirements for beef cattle? Swine? Sheep? Horses?
7. What types of facilities can be used for beef cattle? Swine? Sheep? Horses?
8. What are the current regulations affecting animal waste management?
9. How much waste is produced by the various animal species?
10. What are methods of collecting animal waste?
11. What are methods of storing animal wastes?
12. How can animal waste be utilized?
13. Why is ventilation important in animal facilities?
14. What are some objectives of animal rights organizations?
15. Why should one be concerned with animal rights organizations?
16. How can animal producers make known their views on animal rights issues?

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Meeting the Environmental Requirements of Animals

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES

1. Use local animal producers and cooperative extension personnel as resource persons for additional information.

2. Conduct field trips to local production facilities to view various facility options. Areas of concern should be capacity, ventilation, waste removal, cost, construction materials, and management.

3. Divide the class into small groups and assign to each group a sample situation. The situations would include size of operation, location, financing available, and animal species to consider. The students would then design a facility to meet the animal requirements and defend that design.

4. Use appropriate VAS units or texts to supplements the information provided.

5. Use VAS Unit #U1059, *Livestock Waste Management* and VAS Filmstrip #F1109, *Introduction to Livestock Waste Management,* and discuss the information concerning waste disposal and laws affecting the various systems used for disposing of livestock waste.

6. Use the information sheets as background information on selected topics.

7. Have students complete Student Worksheet #1 as an introduction to space requirements.

8. Have students complete Student Worksheets #2 - #4 on the planning of livestock handling facilities for various animals, for practical experience in providing acceptable facilities for animals. Use the appropriate Midwest Plan Service handbook as a reference.

9. Arrange for a resource speaker to address the class on the planning of animal facilities and animal waste management.

10. Use Information Sheet #8 as a basis for class discussion on the merits of the concerns of animal rights organizations.

11. Divide the class into small groups and assign to each group an animal rights organization. Have the group write that organization requesting information. Use the information as a basis for class discussion.

12. Form two debate teams, one team acting as animal rights advocates and the other team acting as animal producer advocates. Have the teams debate several issues in which the two sides hold differing views.

13. Obtain a copy of the video tape, *Animal Welfare: The Farmer's Story*, or *Animal Welfare*, for class viewing. Lead the class in a discussion of the information presented. Ask students to answer questions such as:

    a. How does the animal rights issue affect me?
    b. Why should I be concerned with the treatment of animals?

14. Consult the problem area *Identifying and Using Agricultural Organizations, Agencies, and Sources of Information About Agriculture* for a listing of organizations representing bees, mink, rabbit, fox, turkey, and other small area species. These organizations can be contacted for information concerning these animals' requirements.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Meeting the Environmental Requirements of Animals

REFERENCES

1. *Managing the Beef Cow Herd* (VAS Unit #U1010B); *The Swine Enterprise* (VAS Unit #U1029A); *The Sheep Enterprise* (VAS Unit #U1031A); *Caring for Sow and Litter at Farrowing* (VAS Unit #U1037B); *Caring for the Brood Mare and Foal* (VAS Unit #U1041); *Horses and Horsemanship* (VAS Unit #U1047); *Rabbit Raising* (VAS Unit #U1050); *Caring for the Small Laying Flock* (VAS Unit #U1052); *Livestock Waste Management* (VAS Unit #U1059); *Introduction to Livestock Waste Management* (VAS Filmstrip #F1109); *Cattle Handling Facilities* (VAS Filmstrip #F187). Vocational Agriculture Service, College of Agriculture, University of Illinois, 1401 S. Maryland Drive, Urbana, IL 61801. (217) 333-3871.

*2. *Beef Handbook, Housing and Equipment; Swine Handbook, Housing and Equipment; Sheep Handbook, Housing and Equipment.* Midwest Plan Service, Agriculture Engineering, University of Illinois, 332 Agricultural Engineering Sciences Building, 1304 W. Pennsylvania, Urbana, IL 61801. (217) 333-9313.

*3. *Animal Welfare* (Videotape #21-751-7, 30 minutes). Photo Com, P.O. Box 3135, Pismo Beach, CA 93449. (805) 481-6550.

*4. *Animal Welfare: The Farmers Story* (16mm filmstrip or VHS cassette, 26 minutes). American Farm Bureau Federation, 225 Touhy Avenue, Park Ridge, IL 60068. (312) 399-5700.

5. *The Stockman's Handbook.* (1983). Ensminger, M.E. Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

*Indicates highly recommended reference

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTIONAL RESOURCES

These resources are intended for use by teachers in planning and teaching the materials for this problem area and may be adapted to fit the teaching method(s) used.

INFORMATION SHEET #1 — Animal Environment

INFORMATION SHEET #2 — Pasture versus Confinement

INFORMATION SHEET #3 — Building Location Considerations

INFORMATION SHEET #4 — Ventilation

INFORMATION SHEET #5 — Space Requirements for Swine

INFORMATION SHEET #6 — Space Requirements for Beef Cattle

INFORMATION SHEET #7 — Space Requirements for Horses

INFORMATION SHEET #8 — Animal Rights

TRANSPARENCY MASTER #1 — Recommended Environmental Conditions for Animals (with discussion guide)

TRANSPARENCY MASTER #2 — Types of Swine Buildings (with discussion guide)

TRANSPARENCY MASTER #3 — Types of Swine Buildings (with discussion guide)

TRANSPARENCY MASTER #4 — Floor Arrangements for Farrowing (with discussion guide)

TRANSPARENCY MASTER #5 — Building Systems (with discussion guide)

TRANSPARENCY MASTER #6 — Types of Beef Buildings (with discussion guide)

TRANSPARENCY MASTER #7 — Sample Horse Barn (with discussion guide)

TRANSPARENCY MASTER #8 — Sample Tie Stall for Horses (with discussion guide)

TRANSPARENCY MASTER #9 — Ventilation Systems (with discussion guide)

TRANSPARENCY MASTER #10 — Approximate Daily Manure Production, Without Bedding (with discussion guide)

TRANSPARENCY MASTER #11 — Swine Waste Management Alternatives (with discussion guide)

TRANSPARENCY MASTER #12 — Livestock Waste Control (with discussion guide)

TRANSPARENCY MASTER #13 — Livestock Waste Control (with discussion guide)

INFORMATION SHEET #1

Animal Environment

The environment of an animal consists of all the conditions, influences, and circumstances surrounding and affecting development, growth, and production of that animal. As animals have been concentrated into smaller spaces the requisite knowledge concerning the animal's requirements has increased. A major attempt must be made to understand the natural habitat of a particular species and the behavior which the animal exhibits in that environment. This knowledge can then be used to correct conditions which are not beneficial to the animal's development in confinement. This will be more helpful to improving production than the current practice of simply preventing the results of confined conditions through such management techniques as docking and debeaking. In the long run, trying to emulate the natural condition by altering space allotments and group sizes and promoting exercise will prove profitable. These efforts can then be combined with the genetic gains not only for production traits but also for the ability to adapt to man-made environments.

Among the environmental factors of concern are the following:

1. Feed and Nutrition
    - a. Regularity of feeding
    - b. Underfeeding
    - c. Overfeeding
    - d. Rations low in certain nutrients
    - e. Rations with an imbalance of certain nutrients
2. Weather
    - a. Temperature
    - b. Humidity
    - c. Air movement
    - d. Environmental controls in buildings
3. Stress
    - a. Excitement
    - b. Strangers
    - c. Fatigue
    - d. Space (animal numbers)
    - e. Management Techniques
    - f. Nutrition
    - g. Herd mates
4. Health
    - a. Disease
    - b. Parasites
    - c. Building maintenance

INFORMATION SHEET #2

Pasture versus Confinement

The information provided here is specifically for swine, but the principles apply to all species.

Pasture management is most practical for operators who:

1. Want to feed out pigs with minimum building investment.
2. Have pasture available for proper rotation for disease control.
3. Are tenants.
4. Farrow once or twice a year.
5. Farrow up to about 80 sows per year.

Partial or total confinement systems are recommended when:

1. Top level management is available.
2. A multiple litter farrowing schedule is used.
3. Labor and available space is limited.
4. Capital is available.

Producers raise hogs in confinement:

1. To cut labor and chore time with mechanical feeding and watering.
2. To increase efficiency with better control of feed and diseases, and other management practices.
3. To provide better year-round working conditions for themselves.
4. To reduce animal use of high-value land.

INFORMATION SHEET #3

Building Location Considerations

Drainage — Drainage should be away from farm home or other buildings.

Future Plans for Expansion — Always leave room for more buildings to be located properly with respect to feed storages and roads.

Snow, Sun, and Wind — Some production requires snow control for best efficiency. Locate facilities downwind from residences to minimize odor problems.

Accessibility of Water and Electric Lines — One does not want to have to run water lines any farther than necessary. Be careful, when digging to bury water or electric lines, that the new lines do not interfere with existing lines.

INFORMATION SHEET #4

Ventilation

Ventilation — is a process of exchanging air. Air distributed through a building picks up moisture, heat, dust, and odors and carries them outside the building. By bringing in clean air from outdoors, it is possible to maintain inside conditions within reasonable humidity, odor, and dust levels.

Purpose of ventilation is:

1. To remove moisture from inside buildings.
2. To remove odors from animal waste.
3. To provide fresh air for animals.
4. To remove excess heat in hot weather.

Ventilation requires:

1. Fans to move air.
2. Inlets to distribute incoming air.
3. Outlets to exhaust stale, humid air.
4. Controls to provide automatic operation.

Successful ventilation usually requires:

1. Insulation.
2. Vapor barrier.
3. Supplemental heat.
4. Management and equipment maintenance.

INFORMATION SHEET #5

Space Requirements for Swine

Space requirement recommendations for pigs using partial or total slats

Pig weight or class	Sq ft for partial or total slats
15 - 30 lb	1.7 - 2.5
30 - 60 lb	3 - 4
60 - 100 lb	5
100 - 150 lb	6
150 - market	8
Gestating sows or gilts	14 - 16
Boars (developing)	20
Boars (mature)	40

Space requirement recommendations for pigs using building with outside apron

Pig class	Sq ft
Growing - Finishing	6 sq ft inside plus 6 sq ft outside
Sows	11 - 12 sq ft inside plus 11 - 12 sq ft outside
Boars	40 sq ft inside plus 40 sq ft outside

Space requirement recommendations for pigs using pasture and shade space

Pig class	Pasture	Shade or winter housing
Sows	10 sows/acre	15 - 20 sq ft/sow
Sows and litters	7 sows and litters/acre	20 - 30 sq ft/sow and litter
Boars	1/4 acre/boar	40 - 60 sq ft/boar

INFORMATION SHEET #6

Space Requirements for Beef Cattle

Space requirement recommendations for cattle in a feedlot

Condition	Sq ft/head
Lot surfaced, access to shelter	20 in barn + 30 in lot
Lot unsurfaced, no shelter	50
Lot unsurfaced, and open front buildings	150 - 800
Sunshade	20 - 25

Space requirement recommendations for cattle with buildings and feedlots

Cattle size	Sq ft/head
600 lb to market	20 - 25
Calves to 600 lb	15 - 20
Bedding	1/2 ton / head

Space requirement recommendations for cattle in cold confinement buildings

Condition	Sq ft/head
Solid floor, bedded	30
Solid floor, flushing	17 - 18
Totally or partially slotted	17 - 18
Calving pen	100
Calving space	1 pen / 12 cows

Space requirement recommendations for feeders

Condition (all animals eat at once)	in/head along feeder
Calves to 600 lb	18" - 22"
600 lb to market	22" - 26"
Mature cows	26" - 30"
Calves	14" - 18"
(feed always available)	
Hay or silage	4" - 6"
Grain or supplement	3" - 4"
Grain or silage	6"
Creep or supplement	1 space / 5 calves

INFORMATION SHEET #7

Space Requirements for Horses

Space requirement recommendations for horses in box stalls or sheds

	Size
Broodmare and foaling barn	12' x 12' to 16' x 16'
Stallion	14' x 14'
Barren mare	150 sq ft/animal
Weanling: Yearling	10' x 10'
Ponies	10' x 10'

All stalls or sheds should have a ceiling height of 8' - 9' and doors 8' x 4'.

Feeding equipment

	size	
	Horses	Ponies
Concentrate	16"w x 30"l x 10"d	12"w x 24"l x 8"d
Hay	30"w x 30"l	20"w x 20"l

Mounting height of feeding equipment

	Horses	Ponies
Concentrate	2/3 height at withers 38" - 42"	Same 28" - 32"
Hay	Height at withers	Same
Water	Automatic 24" - 30" Pail 2/3 height at withers	24" - 30" Same

INFORMATION SHEET #8

Animal Rights

Connected with the animal requirements for certain environmental conditions is the public's perception of those same conditions. As land availability and cost and feed costs have contributed to more confined and intensive animal management methods, the amount of publicity surrounding those management methods continues to grow. It is incumbent on producers to know the position of those groups which are adversarial by nature in order to provide a reasoned and informed response. It is also prudent to distinguish between those groups interested in the general welfare of animals and those groups that transfer "rights" we have as human beings to the animal population.

Among the arguments made by animal rights groups are the following.

1. We shouldn't eat meat for moral and nutritional reasons.
2. Confinement is contrary to "natural" methods.
3. Large range herds contribute to unnecessary exposure and negligent management.
4. Animals consume products that could feed the world's starving people.
5. Too many drugs are used in confinement operations to offset sickness and disease.
6. Breeding for high production causes animal stress.
7. Management techniques, such as docking and debeaking, cause pain and stress.
8. Experimentation for disease treatments, surgical procedures, and cosmetics is immoral.
9. Altering environmental conditions for additional production (such as day length on chickens) is wrong.
10. Meat consumption leads to overgrazing, causing deforestation and erosion.

Many other issues and concerns can also be found.

Among the producers responses are the following.

1. Meat provides the eight essential amino acids for protein formation; plant products do not.
2. Confinement provides protection from predators and hunger.
3. Animals utilize otherwise unused areas.
4. Animals consume feedstuffs not suitable for or not able to be utilized by humans.
5. The health of animals contributes directly to economical growth and nearly all drugs have restrictions for their use.
6. Animals are most comfortable in the environment that is most familiar.
7. Experimentation on animals has provided medical advancements not otherwise obtainable.
8. Confinement provides a cheap, plentiful food supply.
9. Confinement allows the producer to more carefully manage animals and confinement reduces common barnyard diseases.
10. Environmentally controlled buildings provide for more comfort than is available "naturally."

Many other responses are possible.

It is important to remember that while animal rights groups may be an aggravation, their concerns can be used for self-examination. As animals became domesticated there was a trade-off that could be seen as beneficial to both animal and man. Though the animal's movement was restricted, this restriction removed the animal's need to expend energy in searching for food and avoiding predators. For the animal producer, there was a saving of energy in raising the animal in a confined area. However, the producer must provide feed, water, shelter, and medication to produce abundant and cheap products. Some of the animal rights groups' concerns are legitimate and need to be addressed. Only by staying informed can animal product producers counter unwarranted claims about animal production techniques.

The following list contains names of some animal rights organizations that can be contacted for information.

1. Fund for Animals
2. Friends of Animals
3. Humane Society
4. Green Peace
5. Natural Wildlife Federation

Recommended Environmental Conditions for Animals

	Temperature		Acceptable Humidity	Commonly Used Ventilation Rates[1]					Drinking Water			
Class of Animal	Comfort Zone			Basis	Winter[2]		Summer		Winter		Summer	
	°F	°C	(%)		(cfm)	(m^3/min)	(cfm)	(m^3/min)	°F	°C	°F	°C
Steer enclosed bldg. on slotted floor	40-70	5-21	50-75	1,000 lb	100	2.1-2.3	200	14.2	50	10	60-75	15-24
Dairy cow	40-70	5-21	50-75	1,000 lb	100	2.8	200	5.7	50	10	60-75	15-24
Sheep:												
•ewe	45-75	7-24	50-75		20-25	.6-.7	40-50	1.1-1.4	40-45	5-8	60-75	15-24
•feeder lamb	40-70	5-21	50-75		15	.3	30	.65	40-45	5-8	60-75	15-24
Swine:												
•Sow, farrowing house	60-70	15-20	60-85	Sow and litter	80	1.4	210	2.8	50	10	60-75	15-24
•Growing-finishing hogs	60-65	15-17	60-85	125 lb	15	.7	75	2.1	50	10	60-75	15-24
Horse	45-75	7-24	50-75	1,000 lb	60	1.7	160	4.5	40-45	5.8	60-75	15-24
Poultry:												
•layers	50-75	10-24	50-75	per bird	2		5		50	10	60-75	15-24
•broilers	85-95	21-27	50-75	per lb body weight	1/2		1		50	10	60-75	15-24

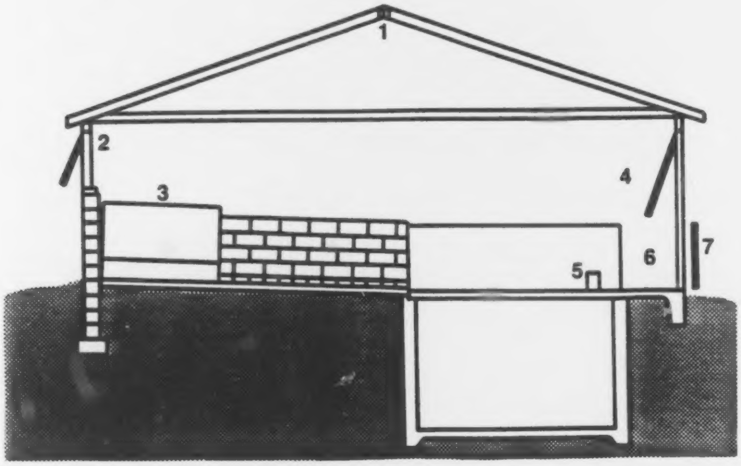
[1] Generally two different ventilating systems are provided: one for winter, and an additional one for summer. Hence, as shown in the table, the winter ventilating system in a beef cow barn should be designed to provide 100 cfm(cubic feet/minute) for each 1,000 - pound cow. Then, the summer system should be designed to provide an added 100 cfm, thereby providing a total of 200 cfm for summer ventilation. In practice, in many buildings, added summer ventilation is provided by opening (1) barn doors, and (2) high-up hinged walls.

[2] Provide approximately 1/4 the winter rate continuously for moisture removal.

Adapted from *The Stockman's Handbook*, 6th edition.

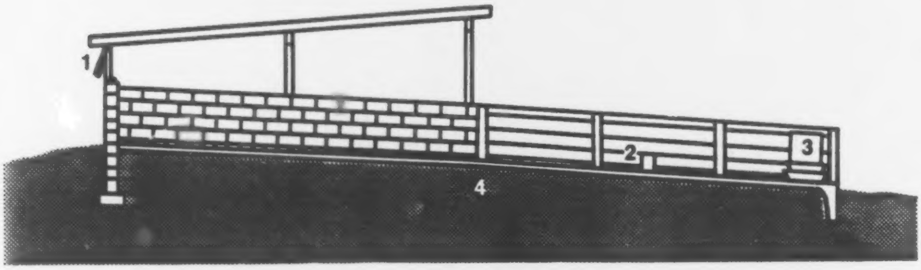
TRANSPARENCY MASTER #2

Types of Swine Buildings



Modified open front, gable style roof

1. Ridge opening
2. Adjustable door for cross ventilation
3. Feeder
4. Translucent panels
5. Waterer
6. Alley
7. Plywood panel



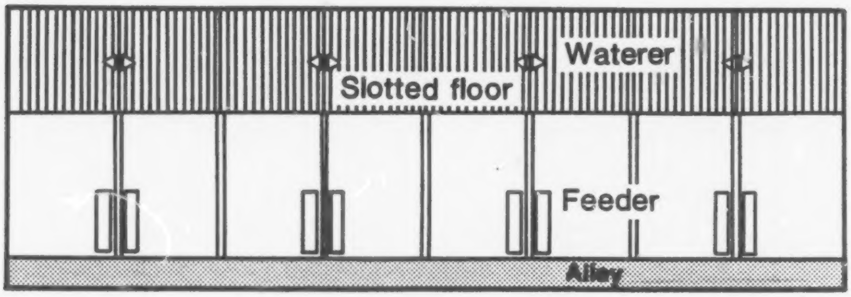
Open front outside apron building with single slope roof

1. Adjustable ventilation door
2. Waterer
3. Feeder
4. Slope

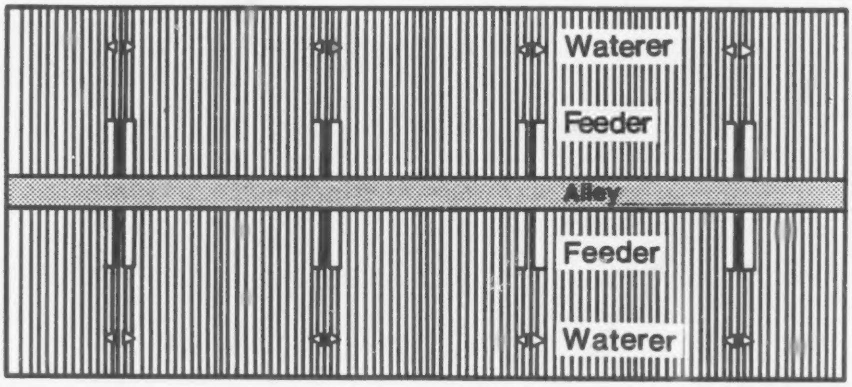
TRANSPARENCY MASTER #3

Types of Swine Buildings

Environmentally Controlled Buildings


Waterer
Slotted floor
Feeder
Alley

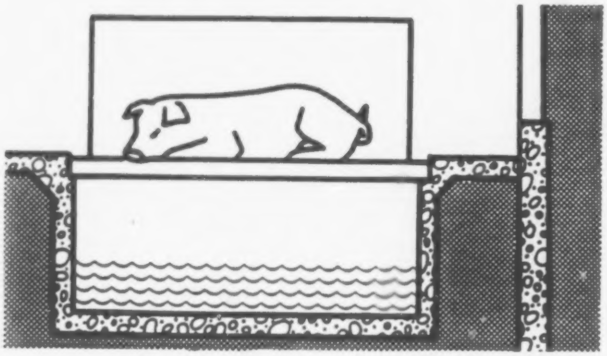
Single row of pens


Waterer
Feeder
Alley
Feeder
Waterer

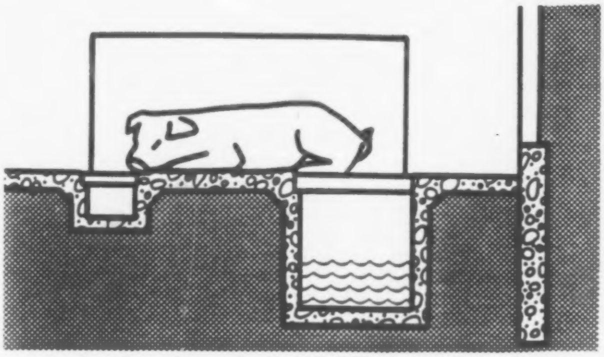
Totally slotted with center alley

TRANSPARENCY MASTER #4

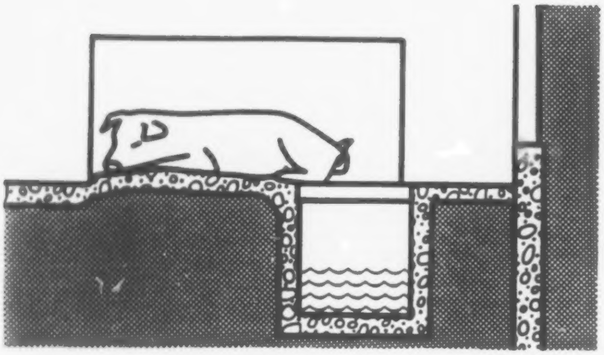
Floor Arrangements for Farrowing



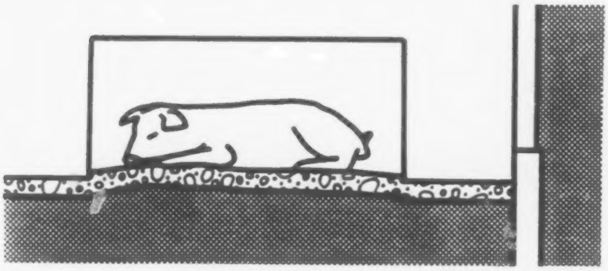
Full pit



Front and rear pit



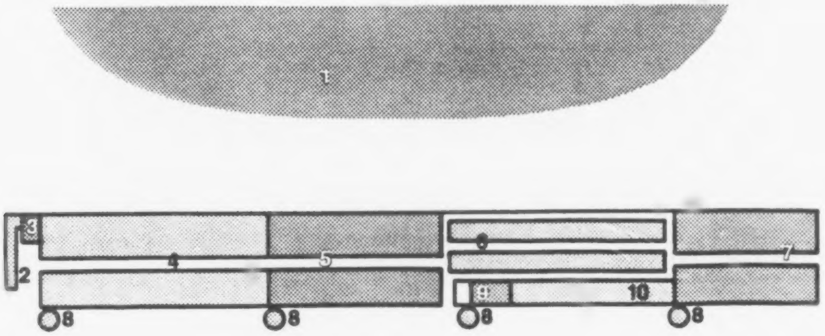
Rear pit



Solid floor

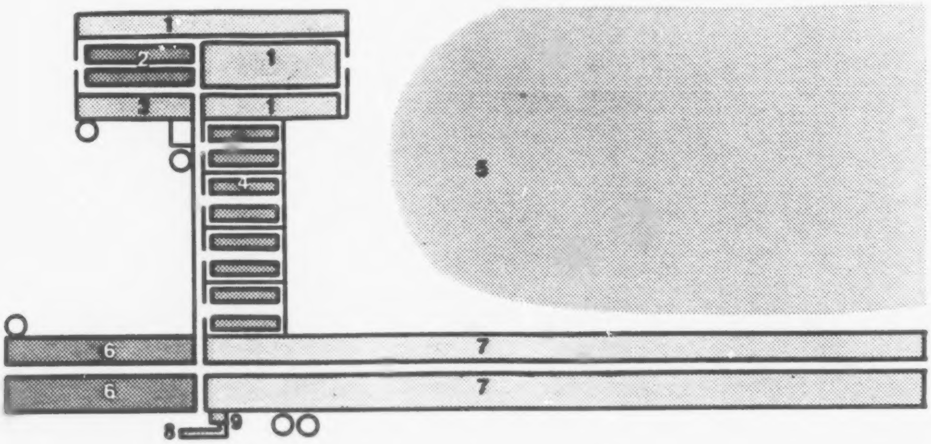
TRANSPARENCY MASTER #5

Building Systems



Production - line system

1. Possible Lagoon Location
2. Loading
3. Scale
4. Growing - Finishing Unit
5. Nursing Unit
6. Farrowing Unit
7. Gestation and Breeding
8. Feed Storage Bins
9. Weaning Pens
10. Sow Holding Pens

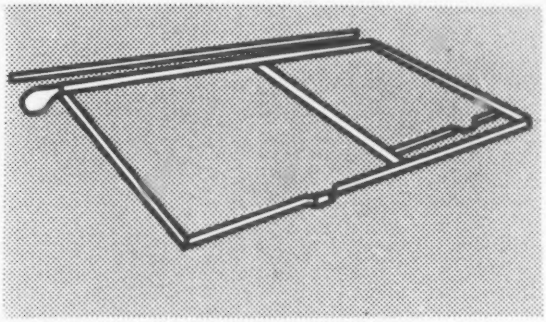


H system

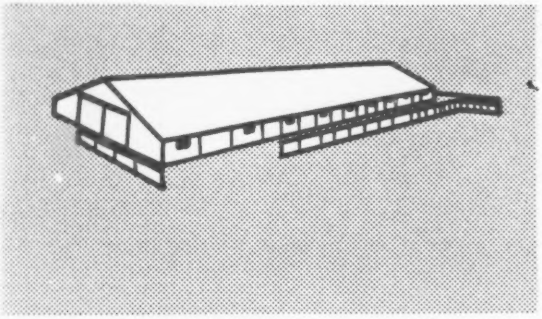
1. Gestation Pens
2. Individual Sow Stalls
3. Breeding
4. Farrowing Rooms
5. Possible Lagoon Location
6. Nursery Unit
7. Growing - Finishing Unit
8. Scale
9. Handling and Loading

TRANSPARENCY MASTER #6

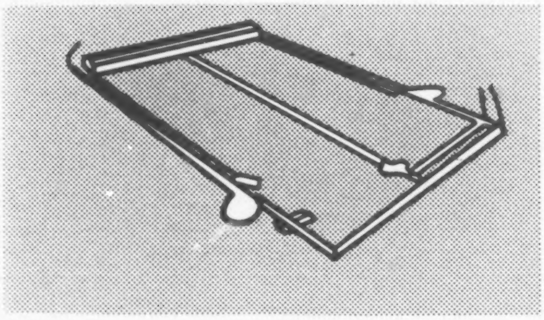
Types of Beef Buildings



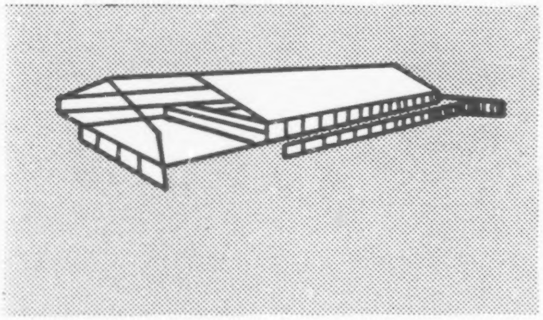
Open feedlot



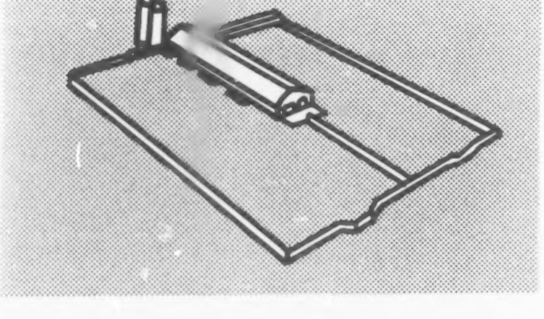
Confinement building
Warm - confinement system



Building and feedlot



Confinement building
Cold - confinement system



Feeding building and lot

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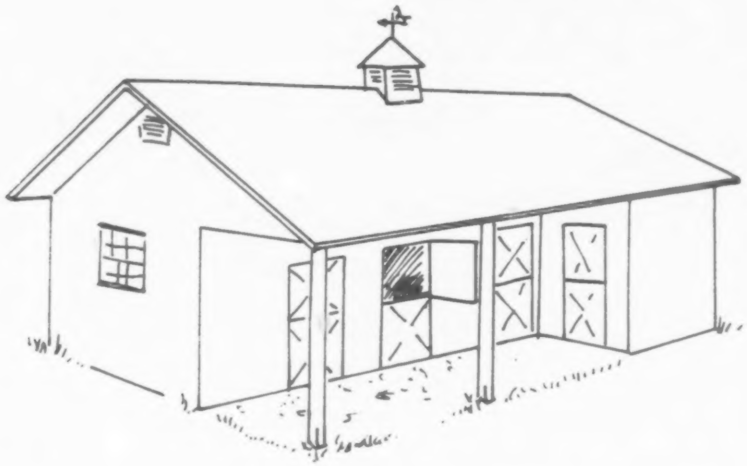
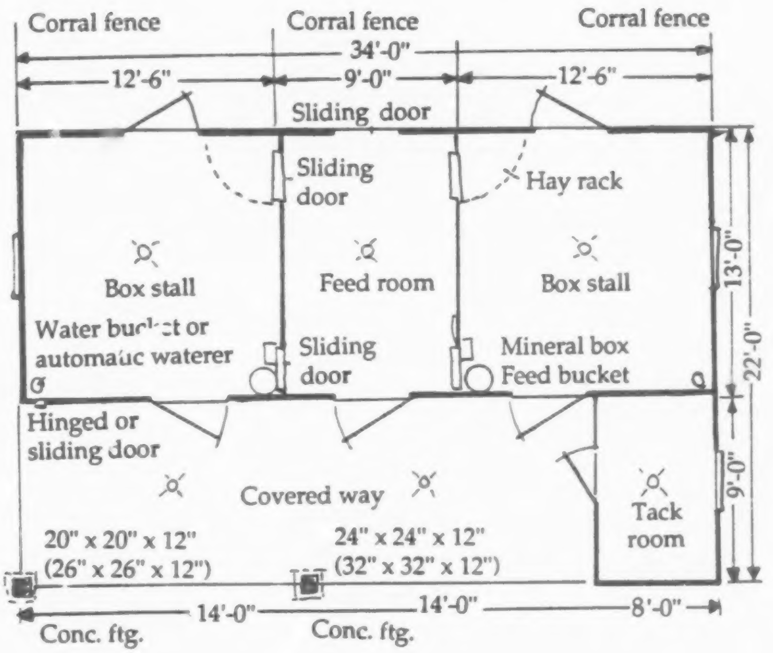
TRANSPARENCY MASTER #7

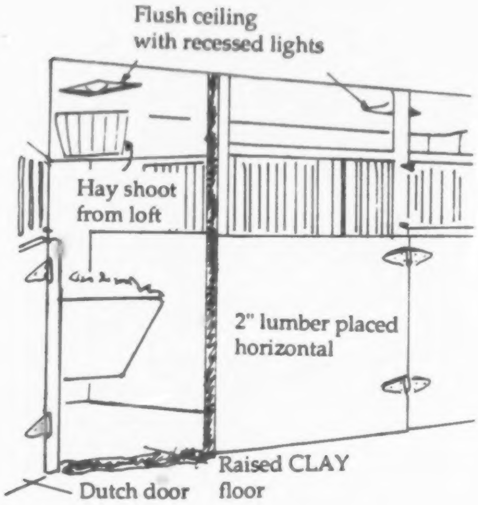
Sample Horse Barn

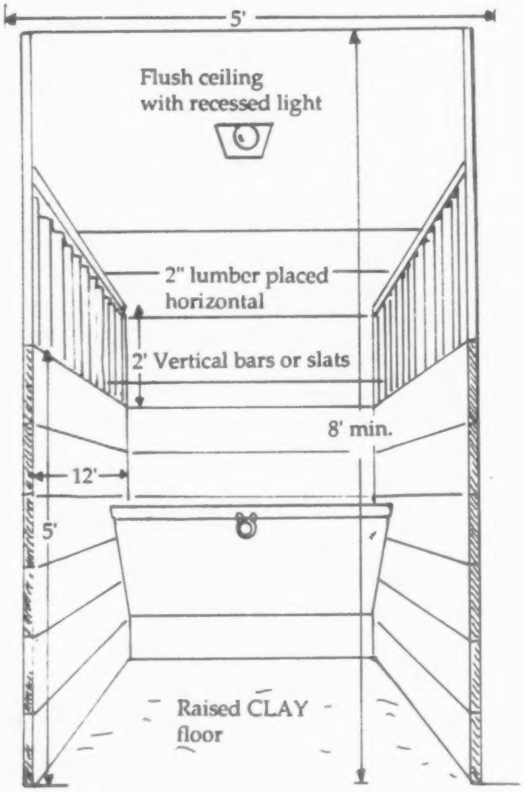



Corral fence
Corral fence
Corral fence
34'-0"
12'-6"
9'-0"
12'-6"
Sliding door
Sliding door
Hay rack
Box stall
Feed room
Box stall
13'-0"
22'-0"
Water bucket or automatic waterer
Sliding door
Mineral box
Feed bucket
Hinged or sliding door
Covered way
Tack room
9'-0"
20" x 20" x 12"
(26" x 26" x 12")
24" x 24" x 12"
(32" x 32" x 12")
14'-0"
14'-0"
8'-0"
Conc. ftg.
Conc. ftg.

TRANSPARENCY MASTER #8

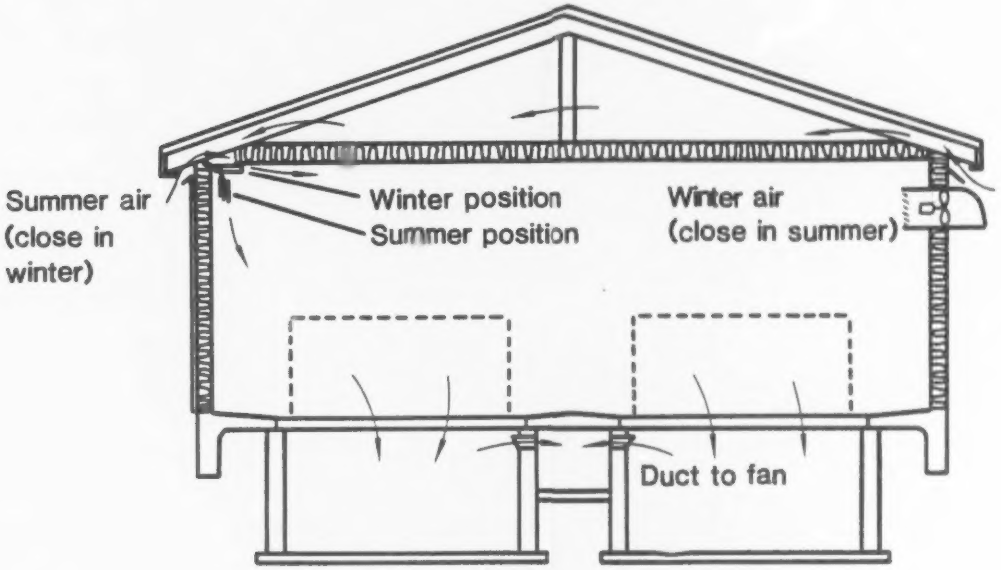
Sample Tie Stall for Horses


Flush ceiling
with recessed lights
Hay shoot
from loft
2" lumber placed
horizontal
Raised CLAY
floor
Dutch door

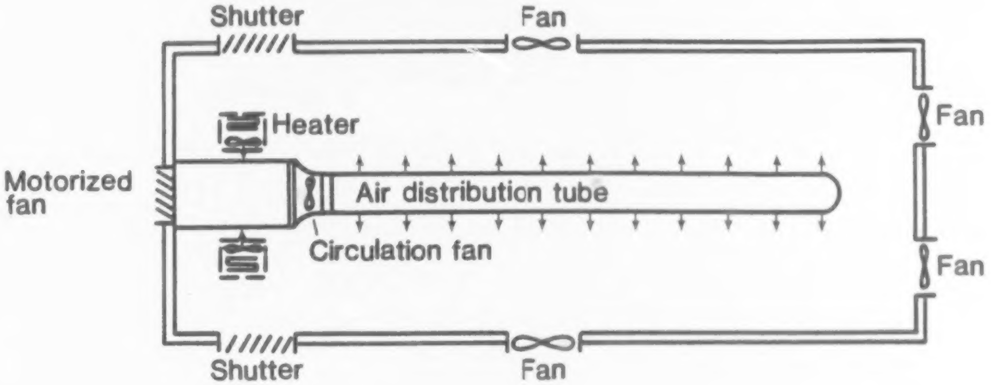

5'
Flush ceiling
with recessed light
2" lumber placed
horizontal
2' Vertical bars or slats
8' min.
12'
5'
Raised CLAY
floor

TRANSPARENCY MASTER #9

Ventilation Systems


Summer air
(close in
winter)
Winter position
Summer position
Winter air
(close in summer)
Duct to fan

Negative pressure (exhaust) ventilation system with pit ventilation


Shutter
Fan
Heater
Fan
Motorized
fan
Air distribution tube
Circulation fan
Fan
Shutter
Fan

Positive pressure intake and air distribution

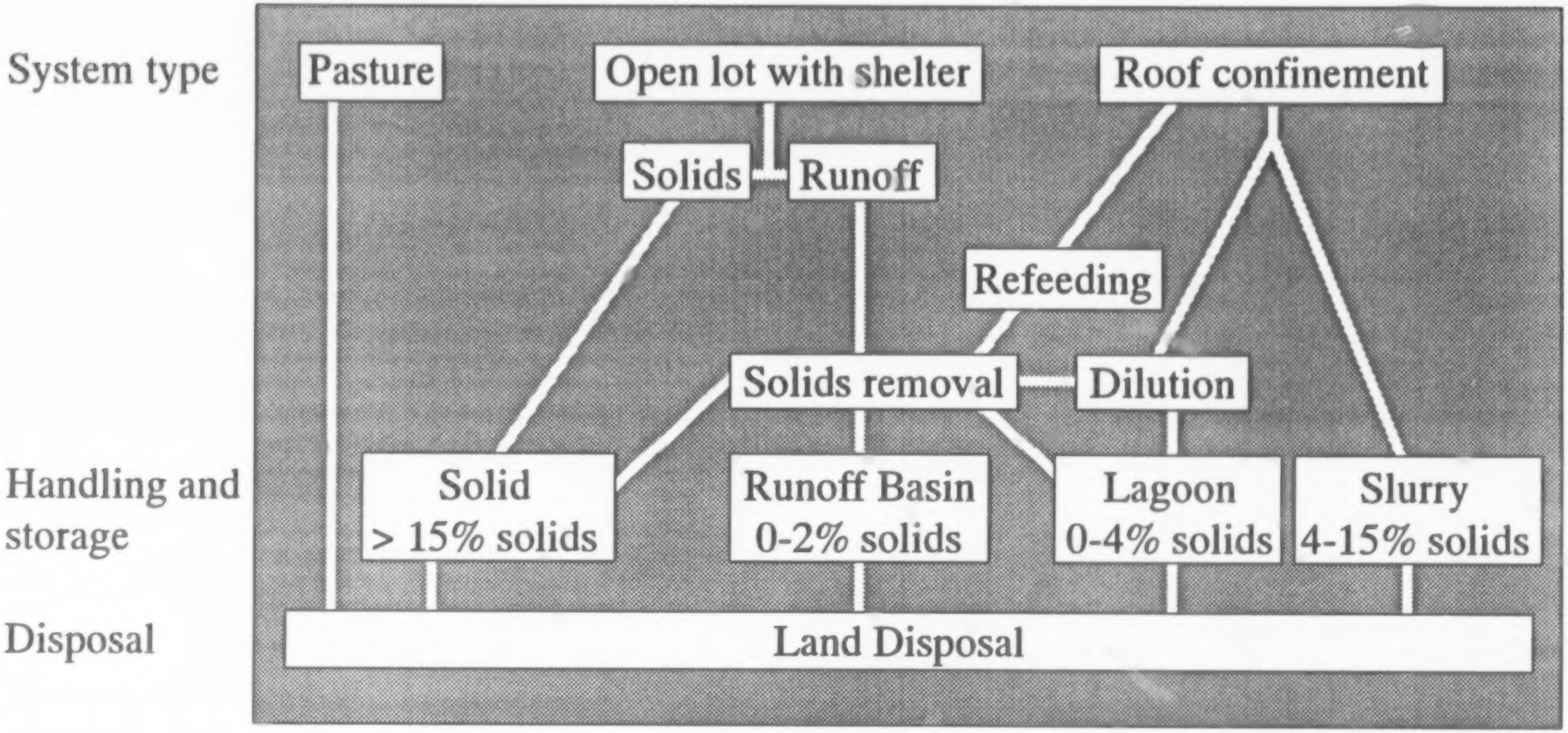
TRANSPARENCY MASTER #10

Approximate Daily Manure Production, Without Bedding[1]

Animal	Cu Ft/Day Solids and Liquids	Gallons/day
1,000-lb cow	1 1/2	11
1,000-lb steer	1	7 1/2
10 head of sheep	1/2	4
10 head of hogs:		
50 lb	2/3	5
250 lb	3 1/2	26
1,000-lb horse	3/4	5 1/2

[1] Adapted from Michigan State University Circular Bulletin #231.

Swine Waste Management Alternatives


System type

Pasture

Open lot with shelter

Roof confinement

Solids

Runoff

Refeeding

Solids removal

Dilution

Handling and storage

Solid
> 15% solids

Runoff Basin
0-2% solids

Lagoon
0-4% solids

Slurry
4-15% solids

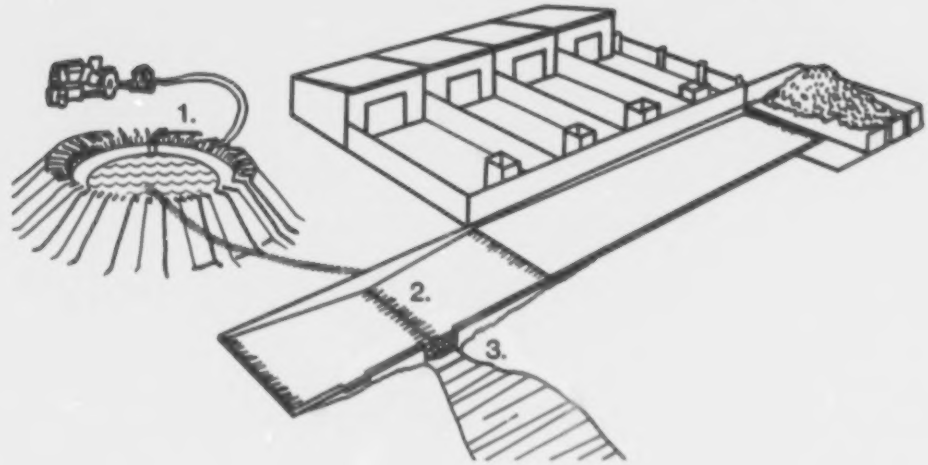
Disposal

Land Disposal

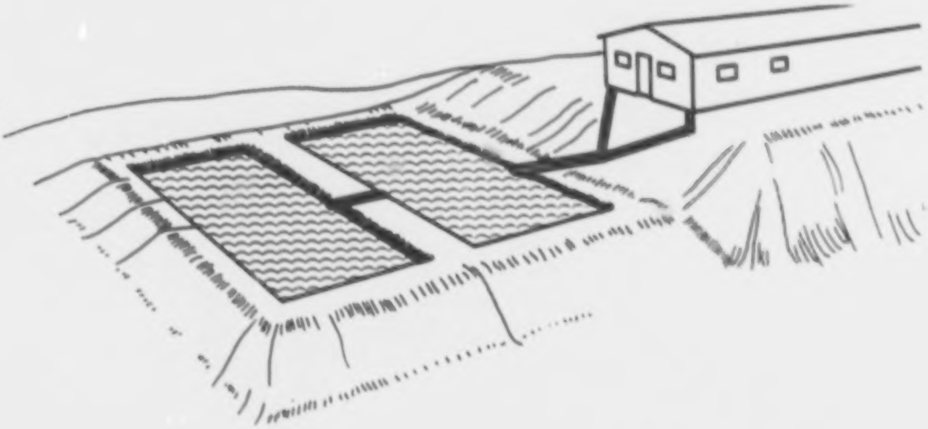
Flow chart of common swine waste management

TRANSPARENCY MASTER #12

Livestock Waste Control



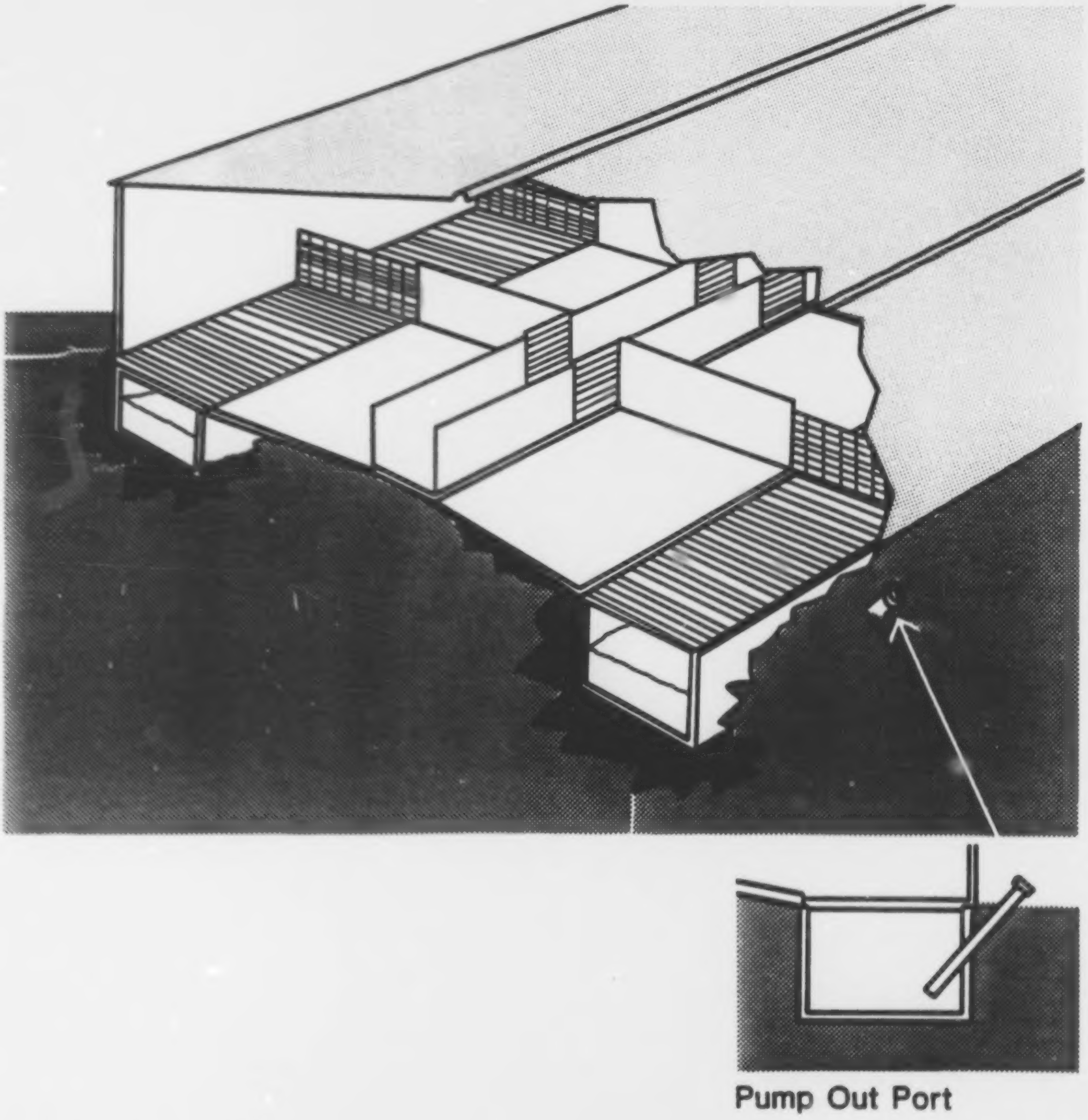
Paved lot with shelter, for solid manure handling.
1. Runoff control - detention and irrigation
2. Solids settling basin
3. Runoff control - infiltration area



Two - stage anaerobic lagoon system for treatment of wastes

TRANSPARENCY MASTER #13

Livestock Waste Control



Confined, partially slotted floors, pit storage, and liquid handling system

TRANSPARENCY MASTER DISCUSSION GUIDE

Transparency Master #1

Lead the class in discussion of the differences in recommendations and reasons for those differences.

Transparency Master #2

A. Identify the parts of the buildings listed on the transparency.

B. Discuss some of the advantages and disadvantages of these types of buildings.
  1. Advantages
    a. A similar weight gain and feed efficiency can be expected in these buildings as in the environmentally controlled buildings used in the midwest.
    b. Cost is less than that of an environmentally controlled building.
    c. Mechanical ventilation is not required.
  2. Disadvantages
    a. There is no control of those environmental components that could restrict pig performance.
    b. Pigs must eat and sleep in the same general area, compared to those buildings with an outside apron.

C. Discuss some of the advantages and disadvantages of the gable roof compared to the single slope roof.
  1. Single slope roof is warmer in the winter.
  2. Gable style roof is generally more expensive.

Transparency Master #3

A. Discuss some of the advantages and disadvantages of these types of building.

  1. Advantages
    a. Environmental components that could restrict pig performance can be controlled.
    b. Temperature and humidity are controlled.
    c. Smaller or younger pigs can be put into these types of buildings sooner than others.
    d. Fly and bird problems are prevented.

  2. Disadvantages
    a. Of all types of buildings discussed, these are the most expensive.
    b. A mechanical ventilation system is required.
    c. High odor levels are possible.

B. Discuss the two different types of floor plans presented on the transparency, and have students give the pros and cons to the different floor plans.

C. Summarize the discussion by stating that, no matter which building is chosen, the choice should be based on the factors of (1) pig performance, (2) labor and management abilities, and (3) economic considerations.

Transparency Master #4

Discuss with the students the different types of floors and pit arrangements. Have students try to identify some advantages and disadvantages of each.

Transparency Master #5

1. Identify the various components of the different types of building systems, and discuss the placement of each component.

2. Describe each of the building systems.
  a. Production-line system — It is a very popular system because of the ease of moving hogs. The moving can be accomplished by one person. Expansion could be accomplished by building additional units beside those already present.
  b. H-system — This system features a breeding and gestation unit, a nursery, and a growing-finishing unit, connected by the farrowing unit. With this system one should be able to completely empty each room for easier cleaning. The expansion is difficult; it is usually done by duplicating the system.

Transparency Master # 6

1. Describe to the students each type of beef building.
  a. Open feedlot — There are no buildings used in this system. Weather protection for cattle is limited to a windbreak fence in the winter, or a sunshade in the summer. Most lots are dirt except for a strip of concrete along the feed bunks.
  b. Building and feedlot — This system consists of an open-front shed or barn with an outside lot that is partly or completely paved. The feed bunks are usually outside; the cattle are fed in mechanical or fence-line bunks.
  c. Feeding building and lot — This system is similar to the previous one except that the feed bunks are under shelter.

   d. Warm-confinement system — This system uses an enclosed, insulated, fan-ventilated building with wintertime control over inside air temperature. The building is ventilated in the summer by opening large doors.
   e. Cold-confinement system — This system uses a building with one side open except for a fence that keeps cattle inside. The air temperature in the building fluctuates according to the outside temperature.

Transparency Masters #7 and #8

1. Lead students in a discussion of each transparency.

2. Describe reasons for the two alternatives and advantages and disadvantages of both.

Transparency Master #9

1. Describe the differences between positive pressure and negative pressure ventilation systems.
   a. Positive Pressure System — Fans are used to force fresh air into the building, and to distribute it by the use of lateral ducts. Most systems are basically pressure intakes, with sidewall exhaust fans to expel moisture, heat, odors, and gases.
   b. Negative Pressure System — Fans are used to draw the air from the building, to create a negative pressure. Air is then drawn into the building through designed air intakes.

2. Summarize the discussion by telling students that in any ventilation system, the incoming air must be well distributed and properly mixed or blended, so that it can remove moisture and heat and do so without creating drafts.

Transparency Master #10

1. Use the information presented as the basis of a class discussion on the fact that the amount of manure a species generates could affect a producer's choice of species for raising, as well as the location of the production facility.

2. Have students list some of the advantages and disadvantages of each of the livestock waste systems.

Transparency Master #11

1. The teacher may wish to draw lines connecting the types of waste management to the types of production systems.

2. The teacher should explain any of the terms on the chart which the students may not understand.

Transparency Master #12

1. Solid manure handling — This transparency shows different methods of separating and disposing of livestock wastes. Paved lots are sloped for drainage and assistance in manure collection. The scraped manure is stockpiled, or hauled immediately to the land. Runoff from these lots is held in a settling basin. There are two alternatives for disposing of the liquid from the settling basin. The first is to use a grass infiltration area to release the runoff to the land. The second is to use a detention basin where the runoff is stored and later used for irrigation purposes.

2. Two-stage anerobic lagoon system for treatment of wastes — This is commonly used with a flushing system. In order for it to work effectively, it is important to have proper design, adequate volume, and proper dilution. This should only be used if some odor can be tolerated. The wastes are flushed out of the building and into a lagoon. The second lagoon is for overflow from the first. It might be necessary to have some method of disposing of excess water from the lagoon.

Transparency Master #13

1. Liquid handling system — Liquid wastes fall through the slats and into the pits below. The pits are then pumped out with liquid waste equipment. Periodic checking of the pits is important because there are certain times of the year when it may not be feasible for liquid wastes to be applied to the land.

2. Have students list some of the advantages and disadvantages of each of the livestock waste systems.

STUDENT ACTIVITIES

STUDENT WORKSHEET #1 — Identifying Space Requirements

STUDENT WORKSHEET #2 — Planning Livestock Handling Facilities — Beef

STUDENT WORKSHEET #3 — Planning Livestock Handling Facilities — Swine

STUDENT WORKSHEET #4 — Planning Livestock Handling Facilities — Sheep

For additional activities, teachers may refer to the "Suggested Teaching Activities and Procedures" section in the Instructor's Guide.

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STUDENT WORKSHEET #1

Identifying Space Requirements

Lot type and condition	Sq ft/head
Partial or total slats for 60- to 100-lb pigs	________
Partial or total slats for gestating sows and gilts	________
Building for sows with outside apron	________
Beef lot — surfaced, no shelter	________
Cold confinement building, solid floor bedded for beef	________
Cold confinement building, totally or partly slotted for beef	________
Building with feedlot for 600-lb to market beef	________
Building using partial or total slats for 150-lb to market swine	________

Figure the total amount of space required for the following situations.

1. How much space would be required for 120 head of 150-lb to market hogs in a building with partial or total slats?
2. How much space would be required for 100 sows in a building with an outside apron?
3. How much space would be required for 60 calves with a weight up to 600 pounds in a building with feedlots?
4. How much space would be required for 50 cattle in a surfaced lot with free access to shelter?
5. How much space would be required in a building for 200 feeder pigs with a weight of 30 - 60 pounds and 100 pigs with a weight of 100 - 150 pounds with partial or total slats?

Figure the capacity of livestock for the following buildings.

1. How many calving pens could be housed in a building that is 50 feet wide and 100 feet long?
2. How many weaning pigs (30 - 60 lbs) could be housed in a total confinement building with total slats that is 30 feet wide and 60 feet long?
3. How many finishing pigs (150 lbs - market) can be housed in a total slats building with 2,000 square feet?
4. How many sows and litters could be placed on 10 acres of land, with shades?
5. Measure the size of the school shop. How many 60- to 100-pound pigs would this space facilitate if it were partially slatted?

STUDENT WORKSHEET #1 — Key

Identifying Space Requirements

Lot type and condition	Sq ft/head
Partial or total slats for 60- to 100-lb pigs	*5*
Partial or total slats for gestating sows and gilts	*14 - 16*
Building for sows with outside apron	*11 inside, 11 outside*
Beef lot — surfaced, no shelter	*50*
Cold confinement building, solid floor bedded for beef	*30*
Cold confinement building, totally or partly slotted for beef	*17 - 18*
Building with feedlot for 600-lb to market beef	*20 - 25*
Building using partial or total slats for 150-lb to market swine	*8*

Figure the total amount of space required for the following situations.

1. How much space would be required for 120 head of 150-lb to market hogs in a building with partial or total slats?
   960 sq ft
2. How much space would be required for 100 sows in a building with an outside apron?
   2,200 sq ft
3. How much space would be required for 60 calves with a weight up to 600 pounds in a building with feedlots?
   900 - 1,200 sq ft
4. How much space would be required for 50 cattle in a surfaced lot with free access to shelter?
   2,500 sq ft - 1,000 in barn and 1,500 in lot
5. How much space would be required in a building for 200 feeder pigs with a weight of 30 - 60 pounds and 100 pigs with a weight of 100 - 150 pounds with partial or total slats?
   1,200 sq ft —600 for feeder pigs and 600 for others

Figure the capacity of livestock for the following buildings.

1. How many calving pens could be housed in a building that is 50 feet wide and 100 feet long?
   50 pens
2. How many weaning pigs (30 - 60 lbs) could be housed in a total confinement building with total slats that is 30 feet wide and 60 feet long?
   450 pigs
3. How many finishing pigs (150 lbs - market) can be housed in a total slats building with 2,000 square feet?
   333 pigs
4. How many sows and litters could be placed on 10 acres of land, with shades?
   70 sows and litters
5. Measure the size of the school shop. How many 60- to 100-pound pigs would this space facilitate if it were partially slatted?
   Divide the number of square feet by 5. Square feet = L x W.

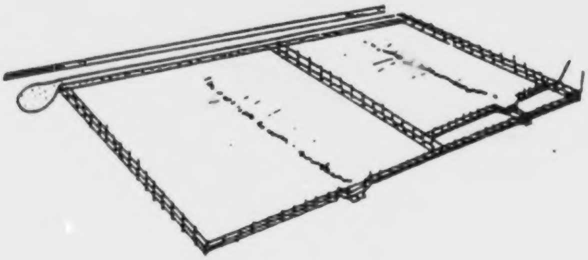
STUDENT WORKSHEET #2

Planning Livestock Handling Facilities — Beef

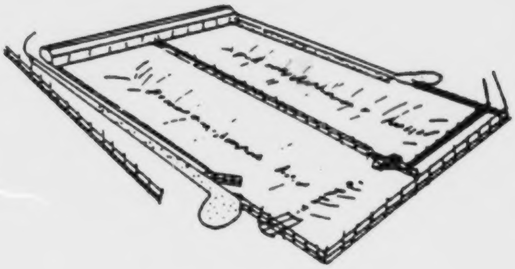
Beef Handling Facilities

A. Identify the type of beef operation

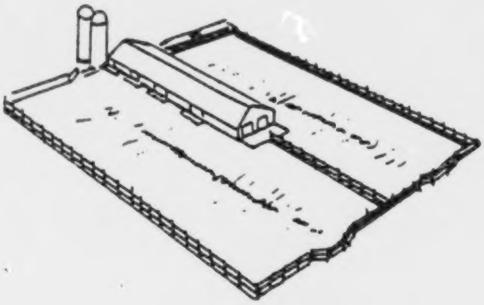
1.



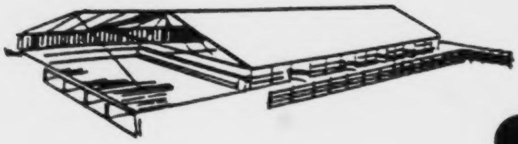
2.



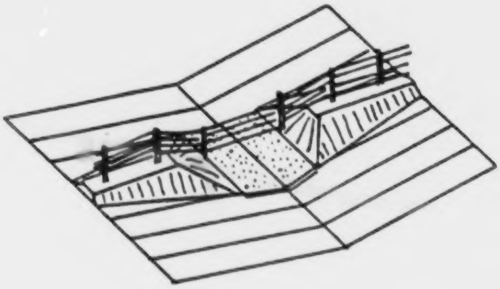
3.



4.



B. Why are the fences and alleys placed on small mounds as shown in the drawing?



C. What factors do you need to consider when deciding on the type of beef facility to construct?

1.
2.
3.
4.
5.
6.

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D. When planning a location for the beef facilities, what four features need to be considered?

1.
2.
3.
4.

E. Identify the space requirements for beef in the following lot types and conditions:

Lot type and condition	sq ft/head
1. Lot unsurfaced except around waterers, along bunks and open-front buildings, and along a connecting strip between the buildings	
2. Lot surfaced, no shelter	
3. Lot surfaced, cattle have free access to shelter	

F. What is the recommended space requirement in square feet per head for the following beef animals?

1. Calves, 600 lbs
2. Feeders, 600 lbs to market

G. What are the advantages of having the feed bunk inside the building?

1.
2.
3.
4.

H. Complete the chart to compare manure handling systems.

Item	Solid Manure	Liquid-Pit	Oxidation ditch	Flushing gutter
Odor				
Fertilizer retention				
Labor required				
Construction cost				
Operation cost				
Maintenance				

I. What special facilities must be available for sick animals?

1.
2.

J. Identify four purposes of ventilation in livestock buildings.

1.
2.
3.
4.

K. What are some reasons ventilation and/or moisture problems occur in cold buildings?

1.
2.
3.
4.
5.

L. List some advantages of providing lighting in beef feedlots.

1.
2.
3.
4.
5.
6.
7.

M. What are the primary reasons for building cattle handling facilities?

1.
2.
3.
4.

N. What seven functions should a complete organized handling system provide?

1.
2.
3.
4.
5.
6.
7.

O. Plan and diagram a cattle handling facility for 50 head. Consider the following:

1. Type of operation
2. General feeding system
3. Cow-calf or feeder operation
4. Waste disposal system

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STUDENT WORKSHEET #2 — Key

Planning Livestock Handling Facilities — Beef

Beef Handling Facilities

A. Identify the type of beef operation

1. *Open Feedlot*
2. *Barn and Feedlot*
3. *Feeding Barn and Lot*
4. *Confinement Barn*

B. Why are the fences and alleys placed on small mounds as shown in the drawing?

A concrete pad prevents mud formation and reduces erosion where a drainage swale must cross the mound.

C. What factors do you need to consider when deciding on the type of beef facility to construct?

1. *How new facilities will blend with existing facilities*
2. *How much land each system requires, and the type of land available*
3. *How much investment and labor are required*
4. *How wind, rain, snow, and temperature can affect location, construction, operation, and rates of gain and feed conversion*
5. *How easily state and federal pollution standards can be met*
6. *Personal preference and management ability*

D. When planning a location for the beef facilities, what four features need to be considered?

1. *Dust and odor*
2. *Runoff*
3. *Waste disposal*
4. *Roads*

E. Identify the space requirements for beef in the following lot types and conditions:

Lot type and condition	sq ft/head
1. Lot unsurfaced except around waterers, along bunks and open-front buildings, and along a connecting strip between the buildings	*150 - 800*
2. Lot surfaced, no shelter	*50*
3. Lot surfaced, cattle have free access to shelter	*20 in barn and 30 in lot*

F. What is the recommended space requirement in square feet per head for the following beef animals?

1. Calves, 600 lbs	*15 - 20*
2. Feeders, 600 lbs to market	*20 - 25*

G. What are the advantages of having the feed bunk inside the building?

1. *Feed is prevented from blowing from the bunks.*
2. *Feed and equipment are protected from rain and snow.*
3. *Cattle eat better during severe weather.*
4. *Cattle can use building for summer shade and winter storms.*

H. Complete the chart to compare manure handling systems.

Item	Solid Manure	Liquid-Pit	Oxidation ditch	Flushing gutter
Odor	*Moderate* *Moderate - strong*	*Moderate*	*Low*	*Low in building, low - strong at lagoon*
Fertilizer retention	*Good*	*Good*	*Poor*	*Poor*
Labor required	*High*	*Moderate*	*Low*	*Low*
Construction cost	*Low - moderate*	*High*	*High*	*Moderate*
Operation cost	*Low*	*High*	*Moderate*	
Maintenance	*Low*	*Low*	*High*	*Moderate - high*

I. What special facilities must be available for sick animals?

1. *Pens for isolation of sick animals*
2. *Bedded space for 2%-5% of the herd at 40-50 sq ft/head.*

J. Identify four purposes of ventilation in livestock buildings.

1. *Remove moisture from inside building*
2. *Provide fresh air for animals*
3. *Remove excess heat in hot weather*
4. *Remove odors and gases from animal manure*

K. What are some reasons ventilation and/or moisture problems occur in cold buildings?

1. *Buildings don't provide natural ventilation, usually because of inadequate openings.*
2. *Ventilation needs are ignored.*
3. *Buildings are closed in attempts to increase inside temperatures.*
4. *Attached sheds and roof extensions prevent good natural ventilation.*
5. *Sanitation and housekeeping leave extra moisture sources (manure, wet bedding, leaky waterers).*

L. List some advantages of providing lighting in beef feedlots.

1. *Less trouble with predators and cattle theft*
2. *Greater animal safety from the quieting effect of night lighting*
3. *Less feed spoilage, because birds seldom roost over lighted feed banks*
4. *Eating of feed by cattle during cool summer nights*
5. *Reduced stress on newly arrived cattle, which are often agitated by darkness*
6. *Better feed availability for timid cattle*
7. *Reduced feedbunk space per head, because of 24-hr feeding period*

M. What are the primary reasons for building cattle handling facilities?

1. *Direction and control of animal movement.*
2. *Reduction of cost and labor requirements to handle animals*
3. *Safety of workers and animals*
4. *Treatment of animals on the farm*

N. What seven functions should a complete organized handling system provide?

1. *Gathering*
2. *Directing flow*
3. *Holding*
4. *Sorting*
5. *Positioning*
6. *Restraining*
7. *Elevating or lowering*

O. Plan and diagram a cattle handling facility for 50 head. Consider the following:

1. Type of operation
2. General feeding system
3. Cow-calf or feeder operation
4. Waste disposal system

(Answers will vary.)

STUDENT WORKSHEET #3

Planning Livestock Handling Facilities — Swine

Swine Handling Facilities

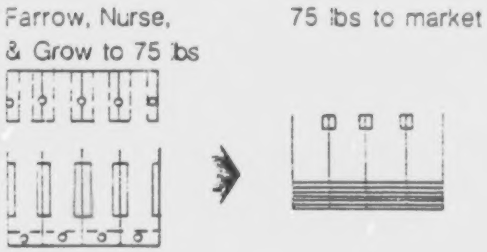
A. Deciding on the type of swine production involves the consideration of many factors. When would you recommend each of the following practices?
   1. Farrowing pigs for sale as feeder pigs
      a.
      b.
      c.
      d.
      e.
   2. Farrowing pigs for sale as market hogs
      a.
      b.
      c.
      d.
      e.
   3. Buying and finishing feeder pigs
      a.
      b.
      c.

B. Under which conditions would you recommend pasture management?
   1.
   2.
   3.
   4.
   5.

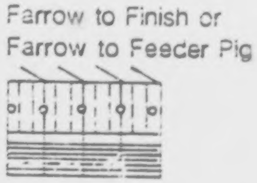
C. When would you recommend confinement systems?
   1.
   2.
   3.
   4.
   5.
   6.
   7.
   8.
   9.

D. Identify the type of production system as either a one-stage, two-stage, or three-stage system.

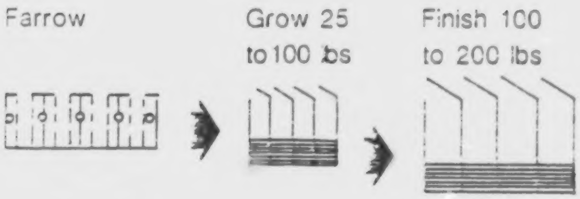
1.


Farrow, Nurse, & Grow to 75 lbs
75 lbs to market

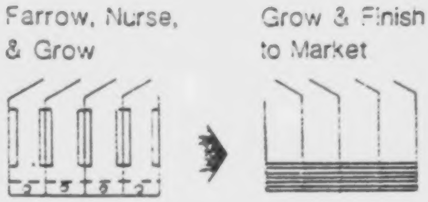
2.


Farrow to Finish or Farrow to Feeder Pig

3.


Farrow
Grow 25 to 100 lbs
Finish 100 to 200 lbs

4.


Farrow, Nurse, & Grow
Grow & Finish to Market

E. List some advantages and disadvantages of free stall farrowing:

1. Advantages

2. Disadvantages

F. Identify the space requirements in square foot per head for swine at the following stages:

1. Finishing, more than 150 lbs ____________
2. Growing, weaning to 100 lbs ____________
3. Gestating sow, bedded area ____________
4. Shade, sow and litter ____________
5. Shade, pigs over 100 lbs ____________

G. Plan and diagram a swine handling facility for 50 head. Consider the following:

1. Product to be marketed
2. Pasture or confinement
3. Building system
4. Litters to be farrowed/year
5. Waste disposal

STUDENT WORKSHEET #3 — Key

Planning Livestock Handling Facilities — Swine

Swine Handling Facilities

A. Deciding on the type of swine production involves the consideration of many factors. When would you recommend each of the following practices?

1. Farrowing pigs for sale as feeder pigs
    a. *When available space is limited, but expansion is desired*
    b. *When feed supplies for finishing pigs are unavailable or costly*
    c. *When labor is available, but capital is limited*
    d. *When a regular income with low investment is desired*
    e. *When there is local demand for feeder pigs*
2. Farrowing pigs for sale as market hogs
    a. *When space is available*
    b. *When feed is inexpensive*
    c. *When labor and capital are both available*
    d. *When there is no local demand for feeder pigs*
3. Buying and finishing feeder pigs
    a. *When caring for baby pigs is not desired*
    b. *When labor is limited, and finishing feeds are available*
    c. *When there is a reliable source of feeder pigs*

B. Under which conditions would you recommend pasture management?

1. *When a minimum building investment is desired for feeding out pigs*
2. *When pasture is available for proper rotation to assure disease control*
3. *When the producer is a tenant*
4. *When farrowing only once or twice per year*
5. *When farrowing up to a maximum of 80 sows per year*

C. When would you recommend confinement systems?

1. *When top level management is available*
2. *When a multiple litter farrowing schedule is used*
3. *When a large number of hogs will be raised*
4. *When labor and available space are limited*
5. *When capital is limited*
6. *When labor and chore time must be reduced with mechanical feeding and watering*
7. *When greater efficiency is needed through better control of feed and diseases and the use of other management practices*
8. *When producers desire better year-round working conditions for themselves*
9. *When high-value land must be freed from use by animals*

D. Identify the type of production system as either a one-stage, two-stage, or three-stage system.

1. *Two -stage*
2. *One-stage*
3. *Three-stage*
4. *Two-stage*

E. List some advantages and disadvantages of free stall farrowing:

1. Advantages
    a. *Labor is saved in turning out sows to eat.*
    b. *Labor is saved in cleaning individual pens.*
    c. *Investment is less if feeders are waterers; pens are cleaner.*
    d. *Most sows are more relaxed.*
2. Disadvantages
    a. *A sow may go out and in up to 15 times a day and usually lays down each time she enters a pen.*
    b. *If a sow does not want to nurse her litter she leaves the pen.*
    c. *Some sows carry bedding to the alley to make a farrowing nest.*
    d. *Sows leave pens quickly if there is any draft.*
    e. *If a few pigs get out, it is difficult to return them to the right pen unless they are marked.*
    f. *A sow can lie with her head through the door; pigs can crawl up on her and escape.*
    g. *If feeding space is limited, the sows may have to be fed in small groups.*
    h. *Some producers limit feeding the sows for up to 5 days to help control scours in baby pigs; so sows must be fed in the stalls.*
    i. *If the gate at the back of the pen is too high, an old sow with low slung udder is susceptible to mastitis.*

F. Identify the space requirements in square foot per head for swine at the following stages:

1. Finishing, more than 150 lbs	*8*
2. Growing, weaning to 100 lbs	*3 - 4*
3. Gestating sow, bedded area	*15*
4. Shade, sow and litter	*20 - 30*
5. Shade, pigs over 100 lbs	*6*

G. Plan and diagram a swine handling facility for 50 head. Consider the following:

1. Product to be marketed
2. Pasture or confinement
3. Building system
4. Litters to be farrowed/year
5. Waste disposal

(Answers will vary.)

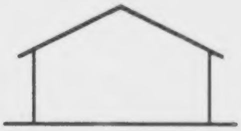
STUDENT WORKSHEET #4

Planning Livestock Handling Facilities — Sheep

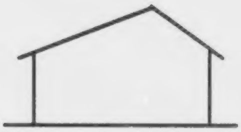
Sheep handling facilities

A. Identify the barn style below and explain when each is used.

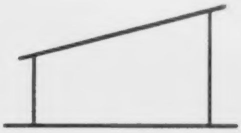
1.



2.



3.



B. What major items need to be considered when planning a sheep operation?

1.

2.

3.

4.

5.

6.

C. What factors need to be considered when choosing a site location?

1.
2.
3.

D. List some practices to follow which can control and minimize waste runoff in open lots.

1.
2.
3.
4.
5.
6.

E. Identify the following space requirements:

Type of space	Space/ewe
1. Feeder space, group fed	______________
2. Shelter space	______________
3. Lot	______________
4. Floor space	
a. solid	______________
b. slotted	______________

F. Design and diagram a sheep handling facility for 50 head. Consider the following:

1. Size of operation
2. Housing system
3. Building needs and location
4. Feeding system
5. Waste management system

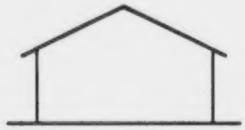
STUDENT WORKSHEET #4 — Key

Planning Livestock Handling Facilities — Sheep

Sheep handling facilities

A. Identify the barn style below and explain when each is used.

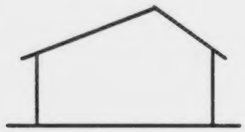
1. *Gable*



The gable roof is the most widely used for both open-front and enclosed buildings. It is moderate in cost and fairly simple to construct and insulate. It is adaptable to natural building ventilation through eaves, sidewall, and ridge openings and clear-span construction with trussed rafters.

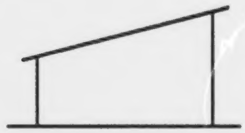
Pole buildings with clear-span wood trusses are used extensively for sheep barns and associated buildings. Wood or steel rigid frames are also clear-span. Post and beam construction is popular in some areas, especially where native lumber is available. Headroom depends on wall height, roof pitch, and type of framing.

2. *Offset Gable*



The offset gable roof has two slopes of different length, so one side of the building is higher than the other. Framing commonly requires interior posts although truss or rigid frame gable roof on the high side of the building may provide a clear-span for 2/3 or more of the building width.

3. *Shed*



The shed roof is widely used on both open-front and enclosed permanent freestanding buildings, attached lean-to additions, roof extensions, and small movable buildings.

A shed roof building is relatively low in cost, provides good headroom, and is simple to build and insulate. Freestanding buildings are easy to ventilate, but ventilation in attached sheds and under roof extensions is often difficult. Most shed roofs are low pitch (slope) to keep the high side of the roof as low as possible. Post and beam construction is most often used for shed roofs.

B. What major items need to be considered when planning a sheep operation?

1. *Size of operation —Number of animals of different age groups to be housed*
2. *Housing systems —Cold or warm housing, or some of each; barn width lot or confinement barn, or some of each; solid or slotted floor, or some of each*
3. *Building needs and location —Remodeled existing buildings or new construction, or some of each; feed storage in or away from the barn; cold or warm protected lambing area; site adequate for buildings, traffic lanes, and expansion*
4. *Feeding —In a lot or barn; handfeeding, self-feeding, fenceline bunks, mechanized bunks, or some of each*
5. *Environmental control —Insulation and vapor barrier; mechanical or natural ventilation; supplemental heat in selected areas for lambing or other; windbreaks*
6. *Manure handling —Solid handling; periodic hauling from barn and/or lot; above ground or under slat storage for solid manures; approved direct surface disposal or detention ponds for liquid runoff*

C. What factors need to be considered when choosing a site location?

1. *A sheep housing facility should be located downwind from the farmhouse; usually north-east or east to minimize summer barnyard odor in the living area.*
2. *Buildings and lots should be at least 200 to 300 feet from the farmhouse.*
3. *Whenever possible, locate sheep barns and lots such that they are protected from winter winds and storms, and benefited from winter sunlight; ideally, land should have a 3 to 5 percent slope away from buildings.*

D. List some practices to follow which can control and minimize waste runoff in open lots.

1. *Locate lots away from streams; at least far enough to permit construction, maintenance, and operation of adequate detention structures.*
2. *Locate the lot at or near the top of a slope, to reduce the outside drainage crossing the lot.*
3. *Consider what the conditions are before building — neighbors, towns, zoning, your own residence.*
4. *Avoid as much runoff as possible.*
5. *Divert all drainage from outside the lots, so only the rain which falls on the lot becomes polluted.*
6. *Build lots no larger than necessary for your flock size.*

E. Identify the following space requirements:

Type of space	Space/ewe
1. Feeder space, group fed	*16 - 20 in*
2. Shelter space	*10 - 12 sq ft*
3. Lot	*25 - 40 sq ft*
4. Floor space	
a. solid	*12 - 16 sq ft*
b. slotted	*8 - 10 sq ft*

F. Design and diagram a sheep handling facility for 50 head. Consider the following:

1. Size of operation
2. Housing system
3. Building needs and location
4. Feeding system
5. Waste management system

(Answers will vary.)

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Identifying Alternative Animal Production Systems: Aquaculture

RELATED PROBLEM AREAS:

1. Understanding the Animal Production Industry
2. Understanding Animal Anatomy and Physiology
3. Understanding Animal Breeding and Reproduction
4. Meeting the Environmental Requirements of Animals
5. Identifying Career Opportunities in Animal Science
6. Classifying Fish (Agricultural Resources Cluster)
7. Stocking Fish (Agricultural Resources Cluster)
8. Feeding Fish (Agricultural Resources Cluster)
9. Managing Fish (Agricultural Resources Cluster)

PREREQUISITE PROBLEM AREA(S): None

LEVEL: Orientation

OCCUPATIONAL TASKS ADDRESSED

Agricultural Business and Management Cluster

Duty D: Marketing Animals and Animal Products

1. Plan marketing schedule
2. Select markets

Duty E: Performing Promotional Activities

1. Analyze and interpret market information

Duty J: Applying Fertilizers and Chemicals

1. Formulate fertilizer

STATE GOALS FOR LEARNING

In planning the instruction for this problem area, teachers can promote the development of several student learning objectives which are related to the State Goals for Learning in Social Sciences and Biological and Physical Sciences. These objectives are listed on the Learning Assessment Plan forms included with this problem area. Those learning objectives marked with an asterisk (*) are taken from the sample lists provided by the Illinois State Board of Education.

Illinois Agricultural Core Curriculum
Agricultural Education 124 Mumford Hall 1301 W. Gregory Drive University of Illinois Urbana, IL 61801

Directors: Dale A. Law, Ed.D.
Principal Investigator: Jerry D. Pepple, Ed.D.
Research Assistant: Janis L. Anderson

Illinois Agricultural Core Curriculum Rev.

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date ____________________
☐ Original submission ☐ Revision
Page _____ of _____

I. LEARNING AREA *(check one)*
☐ Language Arts
☐ Mathematics
☒ Sciences
☐ Fine Arts
☐ Social Sciences
☐ Physical Development/Health

(Affix label or complete district information.)
COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐
District Name
City

Contact Person: ____________________
Title: ____________________
Phone: (   )

II. STATE GOAL FOR LEARNING
As a result of their schooling, students will have a working knowledge of the concepts and basic vocabulary of biological, physical, and environmental sciences and their application to life and work in contemporary technological society.

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
1. Understand how and why chemicals and fertilizers are used in fish production and the effect they have on the quality of the meat.					
2. Understand the different types of fish reproduction, egg collections, and fertilization.					
3. Identify the most popular species of fish.					
4. Detect diseases and know some facts about treatment.					
•5. Compare living organisms by applying a classification scheme.					
•6. Understand major body systems.					
•7. Examine the dynamics of a freshwater system.					

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ISBE 41-78 (1/88)

Identifying Alternative Animal Production Systems: Aquaculture

Agricultural Business and Management
Animal Science

Submission Date ____________
☐ Original submission ☐ Revision
Page ____ of ____

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☐ Mathematics ☒ Social Sciences
☐ Sciences ☐ Physical Development/Health

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)

COUNTY	DISTRICT	ESC

District Name

City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to understand and analyze events, trends, personalities, and movements shaping the history of the world, the United States, and Illinois.

Contact Person: ____________
Title: ____________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
1. Understand the history of aquaculture.					

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ISBE 41-78 (1/86)

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date ____________________
☐ Original submission ☐ Revision
Page ____ of ____

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☐ Mathematics ☒ Social Sciences
☐ Sciences ☐ Physical Development/Health

(Affix label or complete district information.)
COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐
District Name
City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to understand and analyze comparative political and economic systems, with an emphasis on the political and economic systems of the United States.

Contact Person: ____________________
Title: ____________________
Phone: ( )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
1. Recognize the impact of aquaculture on the United States economy and foreign markets.					

ISBE 41-78 (1/88)

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Identifying Alternative Animal Production Systems: Aquaculture

STUDENT LEARNING OBJECTIVES

Upon completion of their study of this problem area, students will be able to:

1. Relate the history of aquaculture.
2. Explain the impact of aquaculture on the U.S. economy and foreign markets.
3. Determine how and why chemicals and fertilizers are used in fish production and the effect they have on the quality of the meat.
4. Know the career options in the aquaculture field in the U.S. and where most production occurs.
5. Identify the different types of fish reproduction, egg collection, and fertilization.
6. Have an understanding of the production and importance of shellfish, crayfish, etc.
7. Identify most popular species of fish.
8. Detect diseases and know some facts about treatment.
9. Understand why the National Aquaculture Act was passed in 1979 and what it accomplished.
10. Know the importance our nation's wetlands have on the production of aquaculture.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Identifying Alternative Animal Production Systems: Aquaculture

PROBLEMS AND QUESTIONS FOR STUDY

1. What is aquaculture?
2. What are the most common fish species raised in Illinois?
3. How did ancient civilizations raise and harvest fish?
4. What are the various jobs and positions available in aquaculture, and what skills are required to move up in the business?
5. How does the development of an aquaculture industry create the need for other supportive occupations?
6. When was aquaculture first introduced into the U.S. and how has it evolved into what it is today?
7. Explain the different intensities of aquaculture. What are some of their advantages and disadvantages?
8. What are some barriers used to retain fish in an area? How effective are they?
9. Why would you want to control the spawning time of catfish?
10. Explain the three methods used to control spawning. What are some advantages of each?
11. To whom do we export aquacultural products, and how much do we export?
12. Do we import aquacultural products? From whom and how much?
13. What fish diseases or problems do we treat the most? How do these diseases affect other fish species or consumers?
14. Why would an aquacultural producer apply fertilizers?
15. What skills and duties are required of a person working in a fish hatchery?
16. How widely are shellfish produced and what effect does their production have on the economy?
17. What effect do the salt wetlands of the east coast have on spawning and aquaculture?
18. Alaska is a large wetland. What and how much does this state produce, and why is it so ideal for the aquaculture industry?
19. Why was the National Aquaculture Act passed in 1979? Why were recent revisions needed?

INSTRUCTOR'S NOTES AND REFERENCES

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INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Identifying Alternative Animal Production Systems: Aquaculture

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES

1. Some students, who can do so, may want to use the project of raising fish as an SAEP.
2. Have some fresh fish available for the students to dissect for studying the internal physiology of fish. This activity may help in showing how and where certain chemicals can harm or enhance a fish's life.
3. If there is a fish hatchery in the area visit it as a class field trip or request from the facility some photographic material to display in class.
4. Have someone from the aquaculture industry talk to the class about the industry and career opportunities within it.
5. Talk about what kinds of soils are needed when constructing a pond.
6. Examine lake or pond water under a microscope to identify nutrients used by fish.
7. Hatch out some fish in the school lab.
8. Conduct a class aquaculture project of hatching, raising, and using fish for stocking local ponds or for eating (perhaps a chapter fish fry!).

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Identifying Alternative Animal Production Systems: Aquaculture

REFERENCES

1. *Our Natural Resources.* Kircher, Harry B., Wallace, Donald L. 5th edition. Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050.
2. *Introduction to the Fishery Sciences.* Royce, William F. Academic Press, Inc., 111th Fifth Ave., New York, NY 10003.
3. Agriculture Education Curriculum, State of Virginia. Richmond, VA 23216.

*4. *Aquaculture: A New Industry for Illinois and Indiana.* Waite, Stephen W., Grossman, Margaret. Illinois-Indiana Sea Grant Program, Cooperative Extension Service, University of Illinois and Purdue University.

5. *Fish Farming Handbook.* Brown, E.E., Gratzek, J.B. AVI Publishing Company, Inc., Division of Van Nostrand Reinhold, 115 Fifth Avenue, New York, NY 10003-1004. (212) 254-3232.
6. *Commercial Catfish Farming.* Lee, Jasper S. Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050.
7. *America's Wetlands.* (Film) The U.S. Fish and Wildlife Service, Vernard Films LTD, Peoria, Illinois 61654. (This film is mostly concerned with wildlife but does show some aspects of aquaculture.)
8. "America Catches on to Aquaculture." *The National Future Farmer.* Antill, Ellen. (April-May 1988).
9. *Fisheries Miscellaneous.* (Serial No. 96-45. H.R. 20). (1980). U.S. Government Printing Office, Washington, DC 20402.
10. *National Aquaculture Act Reathaurization.* (Serial No. 98-16. H.R. 2676). (1983). U.S. Government Printing Office, Washington, DC 20402.
11. *Encyclopedia Americana.* Vol. 11. (1986). Grolier Incorporated. (See article on raising fish in a solar greenhouse on p.299ff).

*Indicates highly recommended reference

INSTRUCTOR'S NOTES AND REFERENCES

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INSTRUCTIONAL RESOURCES

These resources are intended for use by teachers in planning and teaching the materials for this problem area and may be adapted to fit the teaching method(s) used.

INFORMATION SHEET #1 — History of Aquaculture

INFORMATION SHEET #2 — Types of Culture

INFORMATION SHEET #3 — Catfish Spawning

INFORMATION SHEET #4 — Catfish Diseases and Parasites

INFORMATION SHEET #5 — Aquaculture Laws and Regulations

INFORMATION SHEET #6 — Careers in Aquaculture

INFORMATION SHEET #7 — Terms to be Defined

INFORMATION SHEET #8 — Internationally Important Fish and Shellfish Species

INFORMATION SHEET #9 — The Environmental Needs of Fish

TRANSPARENCY MASTER #1 — Food Chain (with discussion guide)

TRANSPARENCY MASTER #2 — Diagram of External Fish Parts and Internal Fish Organs

INFORMATION SHEET #1

History of Aquaculture

The information in this sheet is a collection from a variety of sources and does not contain all of the history of aquaculture because the truth can not be fully known.

Fish culture in China began around 2,000 B.C. Then in 475 B.C. a treatise called "Fish Breeding" was written by Fan Li. This document was surprisingly advanced in its techniques, some of which are still used today in modern aquaculture. At this time the Chinese had already mastered polyculture. This is the simultaneous production of three or more species in a three-dimensional space, using the surface, water column, and bottom. An example of this would be to grow shrimp on the bottom, fish in the middle, and aquatic plants on the surface. China is responsible for nearly half of the total fish farmed in the world today. Aquaculture was then re-introduced into Europe during the Middle Ages. The fish were caught in summer and autumn and stored in "stewponds" for food in the winter. The fish began laying eggs and reproducing in these stewponds. This was the beginning of contained fish culture. In some areas today aquacultural species are grown along with some agricultural crops, such as the raising of fish and shrimp in rice paddies in Asia. Ducks can also be raised with chickens or pigs over ponds in which their droppings will later help to fertilize the soil.

The world's annual production of all cultivated fish, shellfish, and aquatic plants is now slightly over 24 billion pounds; production in the United States is 620 million pounds. In terms of protein production for direct human consumption, fish and shellfish rank *first* in the world (excluding milk and eggs). And, as world population grows, the demand for fish and shellfish is expected to increase similarly. Further, limited ocean resources create an important role for aquaculture to help meet demands for fish and shellfish.

In terms of "on the farm" meat production, aquaculture ranks *fourth* in the world, behind beef and veal, pork and poultry, but ahead of lamb, mutton, and goats combined. However, aquaculture's share of total meat production has increased from about 5% (1974/78 average) to over 10% while the other meat groups, except poutlry, have declined.

In 1983, world commercial fisheries landings accounted for 87.8% of total world production of fish and shellfish; aquaculture accounted for 12.2%. As the contribution of annual world fisheries landings to total annual world fish and shellfish production continues to slip, aquaculture production will make up the difference. The trends of fisheries and aquaculture as contributors to total annual fish and shellfish production in the future are clear. In contrast to the continuing decline in the rate of growth in fisheries landings, world aquaculture production will increase by an average of 8% annually up to and well beyond the year 2000.

Annual world aquaculture production has increased dramatically in recent years and will continue to increase dramatically in the next several decades. U.S. production will also continue to increase rapidly. This recent and projected growth of world aquaculture is stimulated by a number of factors, including population increases, dietary shifts, and advances in aquaculture technology.

Particularly in the United States, aquaculture growth is stimulated by dietary considerations. In recent years, shifts have been noted in the demand for various products as government research institutions have called for increased consumption of cereals, chicken, fish, and fruits and a decreased consumption of red meat and dairy products with high fat contents. In addition, the ability of aquaculture to deliver an attractive fresh product anywhere in the country throughout the year has opened markets in parts of the country previously limited to frozen ocean-caught products. Further, the U.S. trade deficit for fish and fish products continues to climb. In 1986, the trade deficit reached $6 billion. Aquaculture production is an important and real opportunity to help reduce the trade imbalance. In 1986, United States imports of shrimp alone amounted to about $1.3 billion.

Fisheries landings in the United States are also leveling off. We've reached optimal yield levels in most of our fisheries. Between 1973 and 1982, annual U.S. commercial fisheries landings increased from 4.86 billion pounds to 6.37 billion pounds, but the rate of increase has been decreasing. In 1983, U.S. commercial fisheries landings accounted for 94.3% of the domestically produced supply of fish and shellfish. That percentage of production will drop and the percentage of aquaculture's contribution will rise.

Aquaculture production in the United States has shown sharp increases since the early 1970s. FAO estimated 1975 production at about 130 million pounds. In 1977, the National Academy of Sciences (NAS) projected 1985 U.S. production at 500 million pounds and also projected that by the year 2000 it would reach 2 billion pounds if certain administrative and political support to aquaculture development were provided by the government.

The aquaculture community is increasingly concerned that the importance of fish and shellfish to food production and aquaculture's increasingly important role are often ignored or not given adequate attention whenever scholarly studies of agriculture and food research strategies and technologies are conducted.

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The implications and growth of aquaculture in food production have been recognized in the U.S. Department of Agriculture. Expenditures in FY 1988 were anticipated to be at least $20 million or about ten times the amount spent on aquaculture research, development, and education and related support areas in 1978. The various states (about 35) with meaningful production or interest have shown increasing leadership and initiative in aquaculture development and contribute substantial amounts of money to research and extension education.

The domestic aquaculture industry yields about $500 million to producers at the "pond bank." Thousands of farmers and operators are in business — some small, some big. More than 20 important species are produced. Hundreds of companies offer and supply goods and services to the fish and shellfish farmers. Major feed mills are in the fish feed business. Aquaculture is a multi-billion dollar industry in this country. There are two major national and several international professional aquaculture societies with memberships in the thousands. At least 22 states have aquaculture trade associations and there are six major national trade associations. A number of states have established aquaculture development plans — others are in the process of doing so.

Aquaculture will account for at least 25% of world fish and shellfish production in about 30 years, if not sooner, and at least 20% of production in the United States. The opportunities are great in aquaculture.

The story of aquaculture's growth in the U.S. is tied to the health-consciousness of consumers and the diversification of enterprises in mainstream agriculture. The average consumer now consumes 14.7 pounds of fish per year, whereas in 1960 the average consumption was 10.3 pounds per person. The total consumption is growing by 65 million pounds per year.

The U.S. aquaculture's total annual output now exceeds 620 million pounds. Total U.S. output is expected to double by the late 1990s. In the United States, aquaculture was developed in the 1800s with the production of rainbow trout to enhance the industry of recreational fishing. By the 1940s the trout industry grew rapidly and today is the largest cold water fish industry in the U.S. Forty-five states commercially culture trout.

Carp is a breed which in 1877 had begun to be imported to the U.S. because of demands of the European immigrants. By 1897, only twenty years later, the carp had become a national pest; thus the government stocking program was terminated.

The production of bait fish became popular in the early 1900s with a large expansion in the Southeast. Crawfish producers double-crop rice and crawfish in 125,000 acres in Louisiana, Texas, Florida, South Carolina, Arkansas and Mississippi. Since rice plants are a natural crawfish food, crawfish production can be a low-overhead business. It is possible for a farmer to make a profit of $400 per acre .

A major species of fish cultured in Illinois is catfish. Channel catfish production is by far the largest aquacultural enterprise in North America. It accounts for 327 million pounds annually. Catfish ponds cover some 135,000 acres in 10 southern states. The Mississippi Delta alone accounts for 85% of total production. The catfish industry is a billion dollar industry in Mississippi. Farmers are using acres of soybeans just to feed the catfish.

Minnow production is another aquacultural specialty. Arkansas leads all states in baitfish production with annual sales of more than $20 million. A key and essential ingredient still missing, however, is the total integration of aquatic animal and plant agriculture into the mainstream of contemporary U.S. agricultural analysis and thought at all levels. This is a major educational challenge for us all, especially for our youth and for those who instruct our youth.

Young persons entering or considering entering the agricultural community must be exposed to the trends of aquaculture as well as the scientific principles regarding fish husbandry. Teachers must be conversant in the principles of fish farming. Regardless of species, fish and shellfish farming concerns water quality, genetics and reproduction, nutrition and feeding, health maintenance and disease control, engineering, and pond or systems management. The economics of production and marketing are important as well. In short, fish farming involves skills and expertise similar to land-based farming. However, the practice of aquaculture is more complex than traditional farming activities.

Aquaculture, like agriculture, can range from very minimal enhancement of environmental control to very intensive culture. The type of controlled environment depends a lot on whether the animal (or plant) is free during most of its life, such as fish, or is fixed or immobile, such as oysters or rooted plants. In either case, the goal is to create and maintain the most desirable environment to ensure maximum growth. To be a successful commercial aquacultural producer it is most important that you have complete control over the harvest and the sale of the species raised, as well as over their production. Husbandry activities for aquatic species include selective breeding, care of young, feeding, sanitation, environmental modifications, and harvesting. For a fish species to be selected for culture today, it must be able to reproduce in a confined space, have eggs and larvae which are hardy, eat cheap available food, and grow rapidly.

Note: Portions of this text were taken from a proposal by the National Council for Vocational and Technical Education in Agriculture on infusing Aquaculture Education into the Vocational Agriculture Curriculum.

INFORMATION SHEET #2

Types of Culture

Pond culture

Factors that need to be controlled in a pond include:

1. Organisms, such as phytoplankton and zooplankton, and insects and pests.
2. Terrestrial pests.
3. Water temperature and dissolved gases (oxygen).
4. The pH level.
5. Dissolved salts essential for fish growth.
6. Appropriate barriers to prevent fish migration, set up to allow for complete drainage of the water if necessary.

Each pond must be changed and adjusted to meet the changing needs of the fish at their different growing stages.

Beds and Racks

Beds are used for mollusks such as clams since they do not attach themselves to objects. A bed is a suitable bottom that gives limited protection from predators.

Racks are "collectors" used for sessile organisms, such as oysters, which attach themselves to an object to live and grow. These are hung (suspended) in water off the bottom to avoid predators.

Open waters

Extensive aquaculture practices are used in open waters. Some environmental controls are applied to these practices for the production of fish by private firms. There are a variety of barriers that can be created to hold fish in open waters, which include:

1. Nets.
2. Sound.
3. Electrical fields.
4. Curtains of bubbles.

Of these four, the use of nets has proven to be the most effective. The other three have only a limited usefulness.

Fisheries

Fisheries use intensive cultural practices to reproduce, grow, and harvest fish. All eggs are hatched without the help of the parent fish. From the fingerling stage to the adult stage the fish are kept in cement runs with constant running water. Fish raised in hatcheries are used mostly for restocking of ponds, lakes, and rivers.

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INFORMATION SHEET #3

Catfish Spawning

Spawning — Channel Catfish

Female catfish weighing 1-4 pounds will lay approximately 4000 eggs/lb. Fish weighing greater than 4 pounds will only lay 3000 eggs/lb. The optimum temperature for spawning is 70-85°F (21°C). The incubation time ranges from 10 days at 70°F (21°C) to 5 days at 85°F (29°C). With the temperature at 78-82°F the eggs will begin to hatch in about 6 days. The yellow eggs should turn a pink color. Deformation of the eggs will occur at temperatures higher than 85°F. The male catfish is the one who protects the eggs during the incubation time. In intensive practices, such as a fish hatchery, a paddlewheel is used to aerate the eggs in the same manner and motion as a male catfish would. Three days after the eggs hatch the fry will begin to feed and actively swim.

The spawning time can be controlled by:

1. Separating the sexes up to 20-30 days.
2. Keeping the stock at 65-66°F (17-18°C) in May, June, and July.

Spawning Methods

Pond — Place an equal number of males and females in the pond at a rate of 24-150 fish/acre. Place spawning containers in the water facing the center of the pond. Spawns or frys can be either left or removed for incubation. Care must be taken so as not to disturb the male for he may bite.

Advantages — The advantages of using a pond for spawning are that it is an inexpensive method and requires minimal equipment. It is a good method to use when no demands are placed on the producer to select, sex, and pair the fish.

Pen — Pens, which are commonly used by hatcheries, are 10 feet long by 5 feet wide. They are made of either wood, wire, or concrete. Pens may be constructed inside a pond. The depth of the water should be 2-3 feet deep.

Advantages — The advantages of using a pen for spawning are that it provides close control, allows more easily for pairing of fish, protects spawning pairs, allows for the use of hormones, and provides for easier removal of certain fish requiring special care.

Aquarium — Two fish are placed in a tank with running water and are injected with hormones to induce spawning. Eggs are immediately removed to a mechanical hatching trough but may be left for the male to care for. This method is used in federal, state, and some private hatcheries.

Advantages — The advantages of using an aquarium for spawning are that spawning can be regulated for convenience, spawning time can be reduced, spawning can be induced in fish that do not naturally spawn, disease transmission is minimized, and once spawning is complete ponds can be stocked with fry of the same size.

INFORMATION SHEET #4

Catfish Diseases and Parasites

Cannel Catfish Virus Disease (CCVD)

This is believed to have its origin in the brood stock. It is transmitted by reproductive cells or fluids associated with reproduction. Fry and fingerlings pick it up through the water. Fish will hang in the water with their head upright and may die within 32 hours. To control this disease, the producer must destroy the brood stock and not use the fry or fingerlings for reproductive purposes.

Fungal Infection

This infection will cause a white cottony growth to appear on the fish. This is more common in hatching troughs. Eggs, fingerlings, and adults need to be dipped in a fungicidal solution as directed by the manufacturer.

Ciliated Protozoan

This is a parasite the will feed on the fish's tissue and body fluids and will cause a high rate of mortality. Nodules will appear on the surface of the fish and the fish can be found trying to scratch off the parasite. A single treatment has no real effect on ridding this pest, but using a variety of treatments as recommended will yield good results.

INFORMATION SHEET #5

Aquaculture Laws and Regulations

National Aquaculture Act of 1980

Rationale:

1. More fish were being harvested than left to replenish the supply.
2. The U.S. imported more than 50% of its fish and shellfish.
3. Domestic aquaculture had the potential for increased growth.
4. Aquacultural products provide not only food but industrial materials, pharmaceuticals, and energy.
5. Aquaculture is desperately needed to help restore our supply of fish and shellfish resources.
6. The responsibility for aquaculture goes to the private sector.
7. Aquaculture has been inhibited by many economic, legal, and production factors.
8. Some usable land for aquacultural practices is subject to other management policies.

Purpose:

1. To declare a national policy for aquaculture.
2. To establish and implement a development plan.
3. To develop programs and encourage activities for the public and private sectors of the communities.

National Aquaculture Act Reauthorization

Purpose:
To continue funding through the fiscal year 1983-1984.

International Law of Fisheries

Laws governing the harvest of fish in international and territorial waters are just as important as those governing mineral resources and oil. The international law is a collection of principles and doctrines that over time have gained acceptance among nations.

Since the beginning of this century the International Council for the Exploration of the Sea (ICES) has investigated and studied fish and their waters, so that with statistics and proofs of its hypotheses, the council can discuss principles and recommend certain practices to national lawmakers. Controversy still exists, however, concerning what waters belong to whom, how much fish resource can be taken from those waters, and who controls the regulation and maintenance of those resources.

INFORMATION SHEET #6

Careers in Aquaculture

1. Chemist of water and plants
2. Geneticist of aquatic plants and animals
3. Veterinarian
4. Biochemist and Physiologist of aquatic plant and animal nutrition
5. Feeds formulator and aquaculture supplier
6. Engineer of aquatic confinement systems, transportation, and protection
7. Aquatic Pathologist and Epidemiologist of fish diseases

All of these careers are necessary to contribute to the goal of increasing what we can produce from our world's waters.

INFORMATION SHEET #7

Terms to be Defined

Biomass — the total weight of the organisms contained in a sample, or an expression of the weight of the organic materials present per unit area or volume.

Broodfish — sexually mature fish used primarily for reproductive purposes. Weight of a broodfish is used to estimate the number of fingerlings produced. Each species of fish matures at a particular time of the year. Different species mature at different ages.

Cage culture — culture proceeding in chambers generally constructed of wire or netting around rigid frames, floated or suspended in large water bodies such as rivers, lakes, or bays.

Extensive culture — the raising of fish in a low density environment where food and nutrients are naturally available.

Fingerlings — small fish from 1 to 10 inches in length. They are raised and used mostly for stock growers.

Fish-for-fee lakes — a lake (or pond) that is stocked with fish and charges a fee for the privilege of fishing in its waters. These are much more common near urban areas and resort vacation spots.

Food Chain — a sequence of organisms, each of which provides food for the next, from primary producers to ultimate consumers.

Fry — a newly hatched catfish until it reaches one inch in length.

Hatching trough — a raceway utilized to hatch the eggs of fish. For catfish they are fitted with paddle wheels.

Intensive culture — the raising of fish in a high density man-made environment with flowing water; nutrients and supplements are added to the water, making this practice more costly than extensive culture.

Monoculture — rearing of a single species in an aquaculture chamber.

Phytoplankton — plant constituents of the plankton community such as algae.

Plankton — microscopic plant and animal life floating or drifting in water.

Polyculture — rearing of two or more noncompetitive species in the same culture chamber.

Sessile organisms — organisms that attach themselves to an object such as a rock to live and grow.

Spawning — the process of producing and laying eggs which is sometimes preceded by migrating or building a nest and then followed by the care of the young. Spawning requires the expenditure of a large amount of energy by the fish, so a recovery period is usually necessary.

Stocker production — a stocker-sized fish is between fingerling and food size. This is the least common type of fish production.

INFORMATION SHEET #8

Internationally Important Fish and Shellfish Species

Fish

Carp (*Cyprinus carpio*) — Freshwater; originally domesticated in China, but now worldwide; probably the most widespread and important single fish species under cultivation.

Chinese Carps, including Grasscarp (*Ctenopharyngodon idella*), Silver Carp (*Hypothalmichthys molitrix*), Snail Carp (*Mylopharyngodon piceus*), and Bighead Carp (*Aristichthys nobilis*) — Freshwater; native to China, but now also raised in Russia and Southeast Asia. Species complex feeds at all levels of the water as well as on the bottom and uses a given water body efficiently. Induced spawning is successful.

Tilapia (several species) — Freshwater, but can tolerate substantial salinity; originated in Africa, but is now widely distributed throughout the tropics. Some species feed on algae and also thrive on extraneous food. Prolific breeders that guard nest and care for the young, they can give high yields per unit surface under intensive management.

Catfish (several species of *Ictalurus* and *Pangasius*; *Clarius batrachus*) — Freshwater; cultured in the southern United States and in tropical Asia. Induced spawning is successful and selective breeding possible. Considerable expansion of catfish culture is likely.

Mullet (several species of *Mugil*) — Brackish and marine water; cultured in subtropical and tropical Northern Hemisphere inshore areas. Larvae are presently gathered from wild stock but induced breeding experiments are under way; likely to increase in importance.

Milkfish (*Chanos chanos*) — Brackish and marine waters; cultured in southeast Asia. Larvae now gathered from wild stock; when breeding experiments succeed, it is likely to increase in importance.

Salmon (*Salmo salar;* several species *Oncorhynchus*) — Spawns in freshwater, but grows in the sea; cultured in north temperate zone. Selective breeding is possible. Its culture by man is responsible for environmental deterioration.

Trout (several species of *Salmo* and *Salvelinus*) — Freshwater, but can be acclimatized to sea; originated in north temperate zone, but now worldwide; cultured very intensively with high yields for food and sport.

Yellowtail *(Serida quinqueradiata*) — Marine; cultured in seas of Japan. Young are collected at sea, reared in net enclosures, and produce high yields.

Shellfish

Mussels (*Mytilus edulis* and *Mylitus*) — Freshwater and marine water; cultured in France, Spain, and in southeast Asia; high yield of flesh attainable with labor-intensive methods. Optimizing larval survival and bed sanitation remains the main goal of management.

Oysters (*Ostrea* and *Crassostrea*) — Brackish water; cultured mainly in France, the United States, Canada, and Japan. Culture methods now mainly provide attachment throughout entire water column; experiments with selective breeding underway.

Pearl Oyster (*Pinctada*) — Brackish water; cultured in Japan; similar to oyster culture, but does not require controlled breeding.

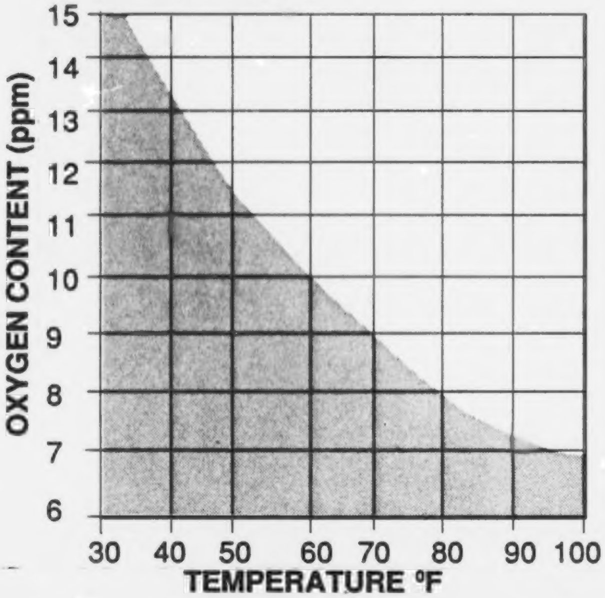
Shrimp (several species of *Penaeus* and *Metapenaeus*) — Marine; cultured in southeast Asia and Japan; extensive in tropical Asia; intensive in Japan where it produces large, high-priced specimens.

INFORMATION SHEET #9

The Environmental Needs of Fish

Temperature — Fish are cold-blooded animals, so their body temperature will be the same as that of the water. Most fish have adapted to a temperature range of 40-50°F. All fish have an optimum temperature range at which they will grow. Within this range the fish will grow rapidly but as temperatures reach the outer limits of this range the fish will begin to eat less and less. At temperatures out of this range fish will become stressed and most likely very ill as they stop eating entirely and begin to lose weight. Fish have adapted to a gradual change in temperatures so when there is a sudden change of 10-15°F the fish will become very stressed.

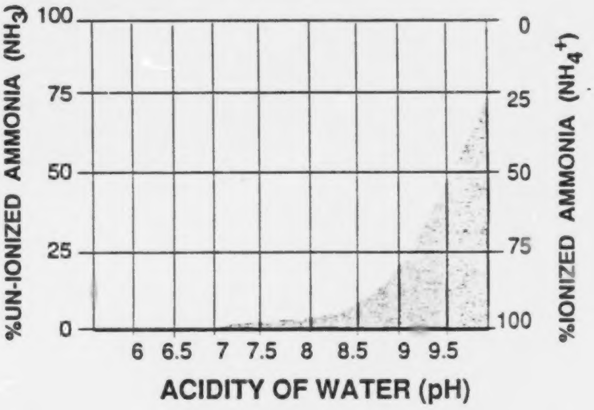
Oxygen Saturation at Different Water Temperatures



Oxygen — Fish need oxygen and breathe a lot like we do by releasing carbon dioxide. They take the oxygen from the water as it passes over their gills, just as our lungs take oxygen from the air that enters them. The amount of oxygen in water ranges from 0 to 9 parts per million (ppm). The higher the 0_2 content the less energy it takes for the fish to breathe so the more weight it can gain. Water is said to be "saturated" when it contains all the 0_2 that it can dissolve. The amount of 0_2 can vary, however, depending on the temperature of the water. At 68°F water can hold 9 ppm of 0_2, but only 7.5 ppm at 90°F. So oxygen content decreases as the temperature increases.

Ammonia — Ammonia (NH_3) is a gas which is given off by fish feces but which can also kill fish. It takes only 1 or 2 ppm of ammonia gas to kill fish. This gas will also cause stress just like low 0_2 and high temperatures.

Percent of Ammonia in the form of Toxic NH_3 as pH Changes

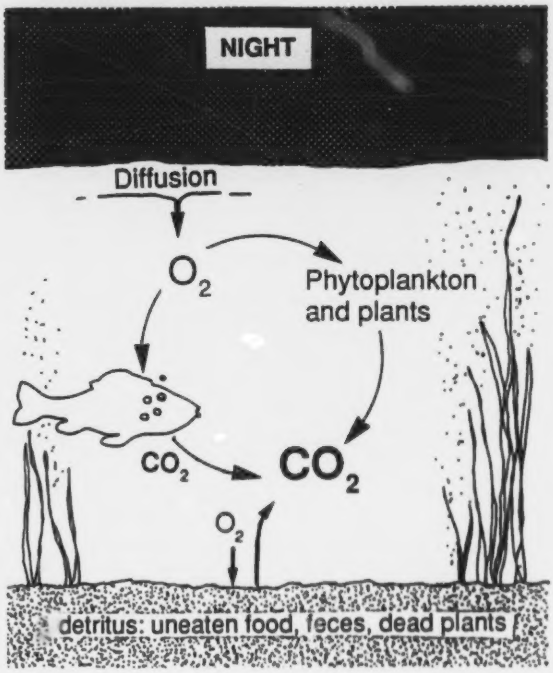


Food — Fish must eat to grow, but food also will contribute to the decreased quality of the water. O_2 is consumed and NH_3 is produced in the same proportion as the amount of food added. 50 percent of dry pelleted food is carbon by weight. What carbon is not used in the respiration process of the fish is released in the feces and thus used by detritivores and bacteria. About 2 percent by weight of dry pelleted food is nitrogen in the form of protein. When fish burn proteins they only use the carbons, so the nitrogen is left in the waste product in the form of ammonia. Fish will sometimes use the nitrogen to make proteins as they grow.

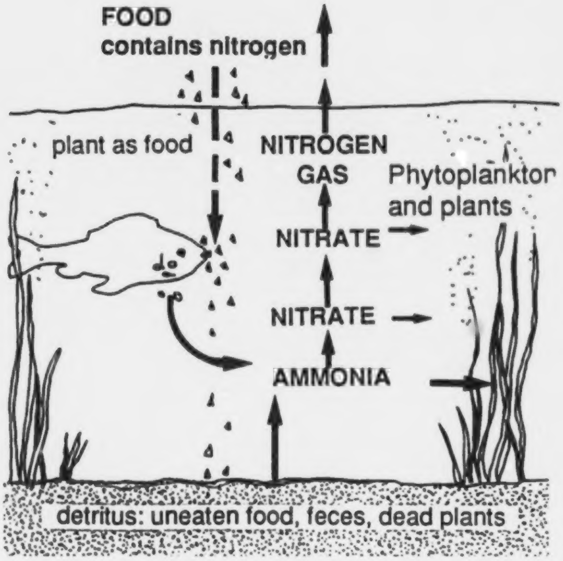
pH — Water that is neutral, in other words, not acidic or alkaline, will have a pH of 7. A pH value above 7 is said to be alkaline, and below 7, acidic. The majority of fish prefer a pH range of 6.5 to 8.0. Fish can become stressed or go into shock from a rapid pH change. The ammonia will change form depending on the pH level. As the pH level rises so does the ammonia in the form of gas which can be lethal to fish. The lower the pH level the more the ammonia will take the form of a positive ion which is harmless to fish.

Photosynthesis — Just as plants above water absorb CO_2 and give off O_2, so do plants that grow underneath the water. Not only do plants use the CO_2 but they also remove the NH_3 from the water to produce plant proteins. So it is quite necessary for fish to have green growing plants in their environment just as humans need plants and trees for survival. Plants only give off O_2 when there is sufficient light. When lake or pond surfaces become overgrown with plants, sunlight cannot reach underwater plants. Therefore, the amount of O_2 given off by these underwater plants and used by fish will be decreased. It is important that some of the surface plants be harvested so that the fish can continue to grow at their maximum rate.

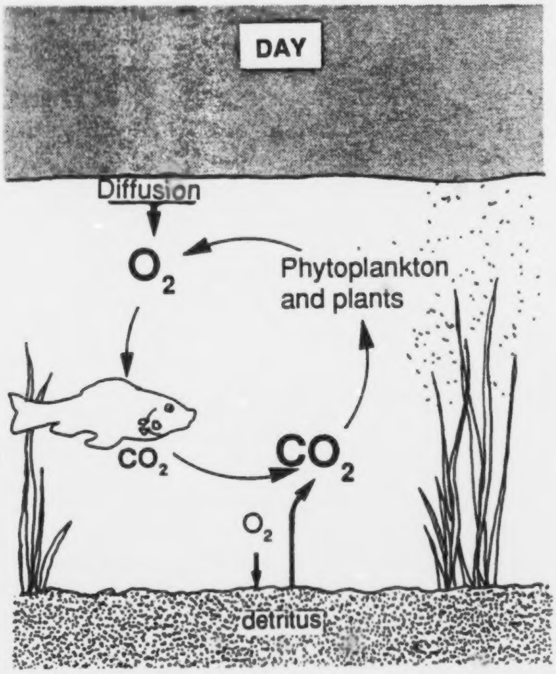
O_2/CO_2 Cycle: Night


NIGHT
Diffusion
O_2
Phytoplankton and plants
CO_2
CO_2
O_2
detritus: uneaten food, feces, dead plants

Nitrogen Cycle in Water

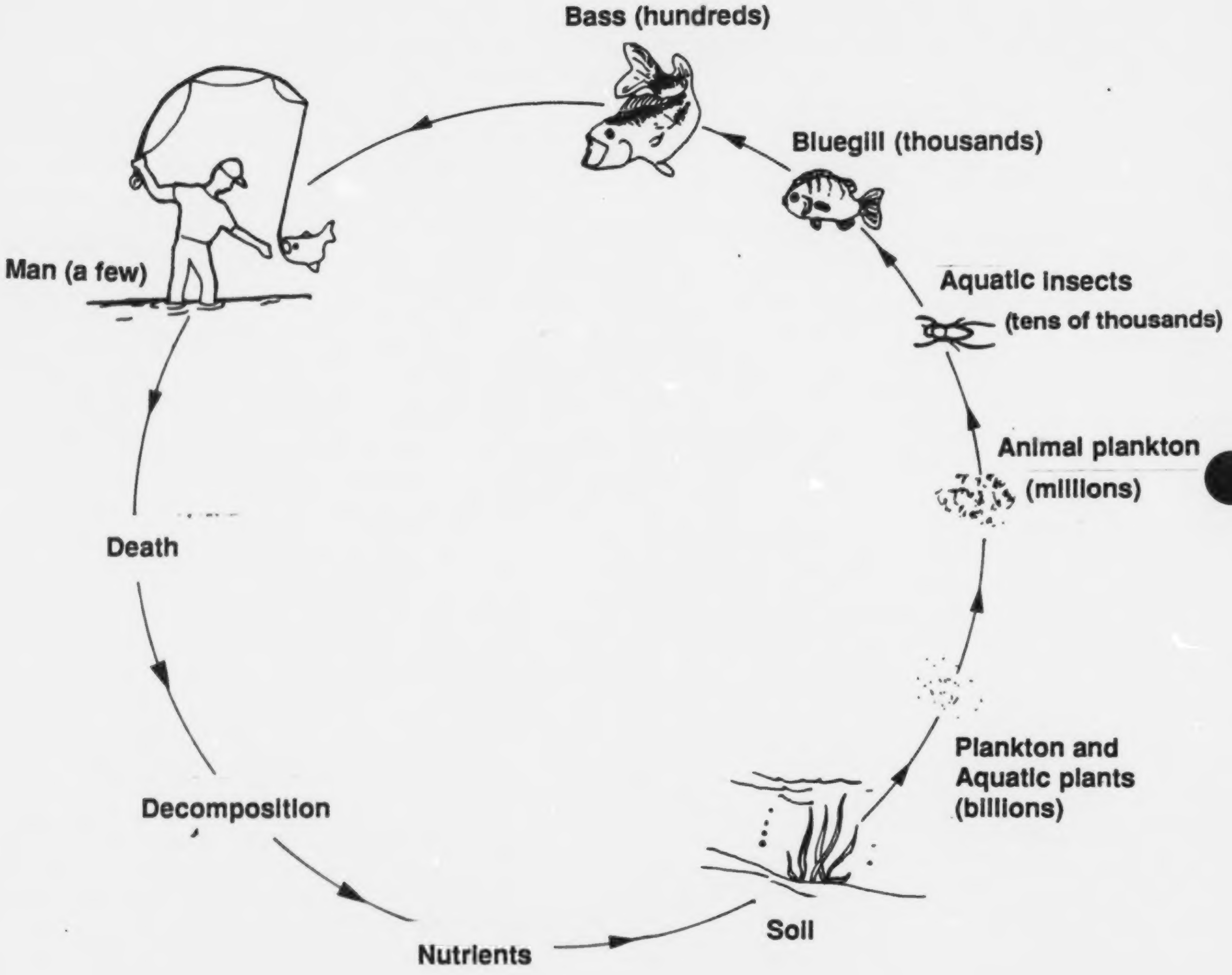

FOOD contains nitrogen
plant as food
NITROGEN GAS
Phytoplankton and plants
NITRATE
NITRATE
AMMONIA
detritus: uneaten food, feces, dead plants

O_2/CO_2 Cycle: Day


DAY
Diffusion
O_2
Phytoplankton and plants
CO_2
CO_2
O_2
detritus

TRANSPARENCY MASTER #1

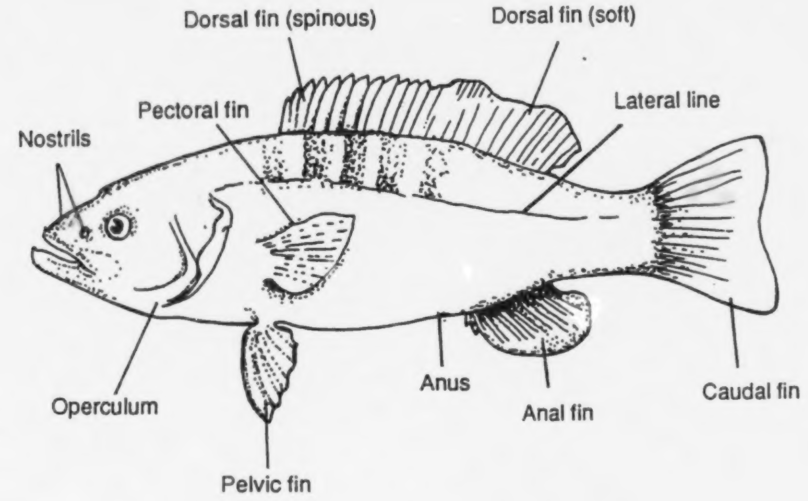
Food Chain


Bass (hundreds)
Bluegill (thousands)
Aquatic insects
(tens of thousands)
Animal plankton
(millions)
Plankton and
Aquatic plants
(billions)
Soil
Nutrients
Decomposition
Death
Man (a few)

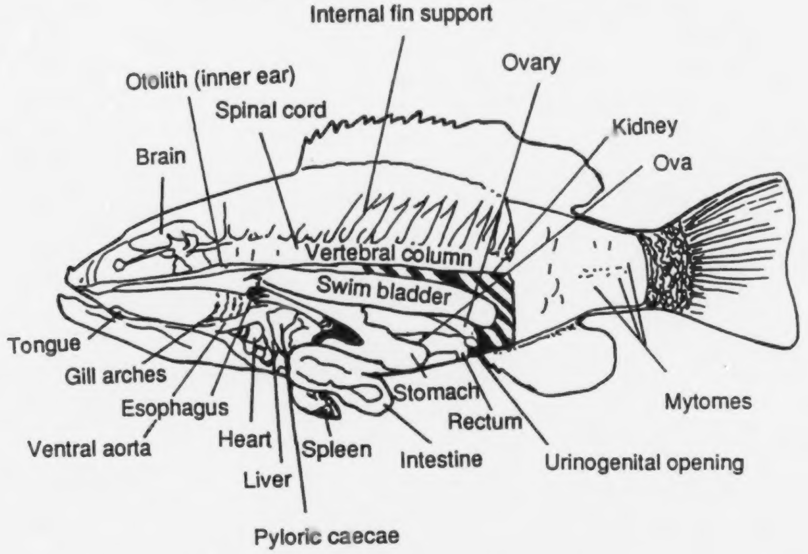
TRANSPARENCY MASTER #2

Diagram of External Fish Parts and Internal Fish Organs

EXTERNAL ANATOMY OF A BONY FISH


Dorsal fin (spinous)
Dorsal fin (soft)
Pectoral fin
Lateral line
Nostrils
Operculum
Anus
Anal fin
Caudal fin
Pelvic fin

INTERNAL ANATOMY OF A BONY FISH


Internal fin support
Ovary
Otolith (inner ear)
Spinal cord
Kidney
Brain
Ova
Vertebral column
Swim bladder
Tongue
Gill arches
Esophagus
Ventral aorta
Heart
Liver
Spleen
Stomach
Rectum
Intestine
Urinogenital opening
Mytomes
Pyloric caecae

Part of the esophageal and stomach walls are cut away revealing the internal structure. Part of the ovary wall has also been removed to show the eggs.

TRANSPARENCY MASTER DISCUSSION GUIDE

Transparency Master #1

All ecosystems operate through food chains, which consist of the transfer of energy through organisms by the process of eating and being eaten. In real life, food chains are connected with other food chains forming food webs.

STUDENT ACTIVITIES

STUDENT WORKSHEET #1 — Aquaculture Quiz

STUDENT WORKSHEET #2 — Matching

For additional activities, teachers may refer to the "Suggested Teaching Activities and Procedures" section in the Instructor's Guide.

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STUDENT WORKSHEET #1

Aquaculture Quiz

1. Define Aquaculture.
2. What is the largest group of animals raised by aquacultural methods?
3. What type of fish is raised the most in the state of Illinois?
4. What is the difference between extensive and intensive culturally raised fish?
5. For what five purposes are fish raised?
6. Name five career opportunities available in aquaculture.
7. What are the three spawning methods and the differences among them?
8. Do ponds require a certain soil base, and if so, what is the best?
9. Why are chemicals and fertilizers necessary to a fish grower?
10. Name ten popular species of finfish

a.
b.
c.
d.
e.
f.
g.
h.
i.
j.

Name four shellfish.

a.
b.
c.
d.

Name four mollusks.

a.
b.
c.
d.

STUDENT WORKSHEET #1 — Key

Aquaculture Quiz

1. Define Aquaculture. *Controlled cultivation and harvest of aquatic plants and animals.*

2. What is the largest group of animals raised by aquacultural methods? *Finfish*

3. What type of fish is raised the most in the state of Illinois? *Channel Catfish*

4. What is the difference between extensive and intensive culturally raised fish?

   Extensive is raising with a low density of fish and in an environment where food and nutrients are naturally available. Intensive is raising with a high density of fish in a man-made environment with flowing water and added nutrients and supplements —also higher cost.

5. For what five purposes are fish raised?

   Food, live bait, research and specimens, stocking and management supplies, and ornamental reasons

6. Name five career opportunities available in aquaculture.

   Chemist of water and plants, geneticist, veterinarian, biochemist and physiologist, feeds formulator and supplier (answers might also include engineer of aquatic confinement systems, transportation, and protection; and pathologist and epidemiologist of fish diseases)

7. What are the three spawning methods and the differences among them?

   The pond method uses a crate into which the spawning pair is placed, and which is then lowered into a pond; it is is the least expensive method, with minimal demands on the producer. The pen method is used by hatcheries and provides a close control over the pair. The aquarium method uses a tank into which the pair is placed; they are injected with a hormone to induce spawning; this method is used for convenience.

8. Do ponds require a certain soil base, and if so, what is the best?

   Yes, clay soils are the best. Clay soil packed along the bottom and sides will help prevent leakage. If water is abundant then it is okay to have some leakage. In a few years the pond will seal itself or you can stock the pond with carp or goldfish to help speed up the process.

9. Why are chemicals and fertilizers necessary to a fish grower?

   Fertilizers (N,P,K, and Ca) will cause an increase in plankton. This in turn causes a decrease in the number of weeds because of the decrease of light penetration. Chemicals are used to fight diseases, fungi, and parasites.

10. Name ten popular species of finfish

    a. *Bass*
    b. *Trout*
    c. *Salmon*
    d. *Walleye*
    e. *Catfish*
    f. *Pike*
    g. *Carp*
    h. *Crappie*
    i. *Perch*
    j. *Bluegill*

    Name four shellfish.

    a. *Shrimp*
    b. *Lobster*
    c. *Crab*
    d. *Crayfish*

    Name four mollusks.

    a. *Clam*
    b. *Oyster*
    c. *Mussel*
    d. *Scallop*

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STUDENT WORKSHEET #2

Matching

1. ________ Fingerling
2. ________ Broodfish
3. ________ Stocker fish
4. ________ Plankton
5. ________ Finfish
6. ________ Extensive
7. ________ Intensive
8. ________ Catfish
9. ________ Spawning
10. ________ Fry
11. ________ Pond Method
12. ________ Pen Method
13. ________ Aquarium Method

a. Largest Illinois crop
b. Microscopic animal and plant life
c. Minimum cost spawning
d. Most widely produced aquaculture crop
e. Requires the use of hormones
f. Young fish 1-10" in length
g. Producing of young
h. Sexually mature fish used for reproduction
i. Pond culture
j. Uses 10' x 5' constructions
k. Hatcheries
l. Between fingerlings and adult in size, used for increasing fish population
m. Hatched catfish

STUDENT WORKSHEET #2 — Key

Matching

1. __*F*__ Fingerling
2. __*H*__ Broodfish
3. __*L*__ Stocker fish
4. __*B*__ Plankton
5. __*D*__ Finfish
6. __*I*__ Extensive
7. __*K*__ Intensive
8. __*A*__ Catfish
9. __*G*__ Spawning
10. __*M*__ Fry
11. __*C*__ Pond Method
12. __*J*__ Pen Method
13. __*E*__ Aquarium Method

a. Largest Illinois crop
b. Microscopic animal and plant life
c. Minimum cost spawning
d. Most widely produced aquaculture crop
e. Requires the use of hormones
f. Young fish 1-10" in length
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j. Uses 10' x 5' constructions
k. Hatcheries
l. Between fingerling and adult in size, used for increasing fish population
m. Hatched catfish

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CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Conserving Wildlife Resources

RELATED PROBLEM AREAS:

1. Maintaining Animal Health
2. Understanding Animal Anatomy and Physiology
3. Meeting Nutritional Needs of Animals
4. Meeting the Environmental Requirements of Animals

PREREQUISITE PROBLEM AREA(S):

1. Basic Principles of Animal Science (Central Core Cluster)

LEVEL: Orientation

OCCUPATIONAL TASKS ADDRESSED:

Agricultural Resources Cluster

Duty B: Applying Laws, Regulations, and Policies

1. Interpret game and wildlife laws

Duty D: Managing Facility Flora and Fauna

1. Identify wildlife species in a selected area
2. Identify endangered or exotic species of plant and animal life in a selected area

Duty H: Applying Safety Practices

1. Implement plans to protect visitors from dangerous animals and other hazards
2. Implement plans to protect animals and plants and other resources from visitors

Agricultural Business and Management Cluster

Duty O: Maintaining Animal Health

1. Identify ailments in animals
2. Administer medication

STATE GOALS FOR LEARNING:

In planning the instruction for this problem area, teachers can promote the development of several student learning objectives which are related to the State Goals for Learning in Biological and Physical Sciences and Social Sciences. These objectives are listed on the Learning Assessment Plan forms included on the following page(s). Those learning objectives marked with an asterisk (*) are taken from the sample lists provided by the Illinois State Board of Education.

Illinois Agricultural Core Curriculum

Agricultural Education 124 Mumford Hall 1301 W. Gregory Drive University of Illinois Urbana, IL 61801

Director: Dale A. Law, Ed.D.
Principal Investigator: Jerry D. Pepple, Ed.D.
Research Assistant: Randy J. Bernhardt

Illinois Agricultural Core Curriculum Rev.

Submission Date ____________
☐ Original submission ☐ Revision
Page ____ of ____

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☐ Mathematics ☒ Social Sciences
☐ Sciences ☐ Physical Development/Health

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)

COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐

District Name

City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to understand and analyze events, trends, personalities, and movements shaping the history of the world, the United States, and Illinois.

Contact Person: ____________
Title: ____________
Phone: ( )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
1. Understand why wildlife is important to humans.					
*2. Summarize methods people can use to conserve resources for future generations.					
3. Develop an understanding of those wildlife species that are endangered or have become extinct in the world, the United States, and Illinois.					
725					726

ISBE 41-78 (1/86)

Agricultural Business and Management
Animal Science

Conserving Wildlife Resources

Submission Date______________________

☐ Original submission ☐ Revision

Page _____ of _____

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)

COUNTY	DISTRICT	ESC

District Name

City

I. LEARNING AREA *(check one)*

☐ Language Arts ☐ Fine Arts
☐ Mathematics ☒ Social Sciences
☐ Sciences ☐ Physical Development/Health

II. STATE GOAL FOR LEARNING

As a result of thier schooling, students will be able to demonstrate a knowledge of world geography with an emphasis on the United States.

Contact Person: ______________________
Title: ______________________
Phone: (   )

By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:

III. LEARNING OBJECTIVES	IV. ASSESSMENT A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	V. EXPECTATIONS Percent of Students Expected to Achieve Objective
*1. Understand why humans generally attempt to control the quality and use of the natural environment.					

ISBE 41-78 (1/86)

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date __________

☐ Original submission ☐ Revision

Page ____ of ____

I. LEARNING AREA *(check one)*

☐ Language Arts	☐ Fine Arts
☐ Mathematics	☐ Social Sciences
☒ Sciences	☐ Physical Development/Health

(Affix label or complete district information.)

COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐

District Name

City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will have a working knowledge of the concepts and basic vocabulary of biological, physical, and environmental sciences and their application to life and work in contemporary technological society.

Contact Person: __________

Title: __________

Phone: ( )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
1. Understand what a habitat is and why wildlife habitat protection is important to prevent endangerment or extinction of wildlife species.					
2. Describe how environmental pollutants can endanger wildlife species.					
3. Understand how humans can work to conserve wildlife species.					
*4. Recognize that good conservation practices depend on understanding the balance between living things and thier environment.					
729					730

ISBE 41-78 (1/88)

Agricultural Business and Management
Animal Science

Conserving Wildlife Resources

Submission Date__________________
☐ Original submission ☐ Revision
Page ____ of ____

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)
COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐
District Name
City

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☒ Sciences ☐ Physical Development/Health

II. STATE GOAL FOR LEARNING

As a result of thier schoooling, students will have a working knowledge of the social and environmental implications and limitations of technological developments.

Contact Person: ________________
Title: ________________
Phone: ( )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Understand ways that people can minimize the depletion of the earth's resources.					
731					732

ISBE 41-78 (1/88)

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Conserving Wildlife Resources

STUDENT LEARNING OBJECTIVES

Upon completion of their study of this problem area, students will be able to:

1. Understand why wildlife is important to humans.
2. Develop an understanding of those wildlife species that are endangered or have become extinct in the world, the United States, and Illinois.
3. Understand what a habitat is and why wildlife habitat protection is important to prevent endangerment or extinction of wildlife species.
4. Describe how environmental pollutants can endanger wildlife species.
5. Understand how humans can work to conserve wildlife species.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Conserving Wildlife Resources

PROBLEMS AND QUESTIONS FOR STUDY

1. What does it mean for a species to be endangered?
2. What does it mean for a species to be extinct?
3. Define habitat.
4. Why is wildlife important to humans?
5. How can air pollution harm wildlife?
6. How can insecticides harm wildlife?
7. How can solid waste disposal harm wildlife?
8. Explain the difference between ecology and conservation.
9. What wildlife species are endangered or extinct in the world?
10. What wildlife species are endangered or extinct in the United States?
11. What wildlife species are endangered or extinct in Illinois?
12. Why do humans attempt to control the environment and what effect does this control have on wildlife?
13. How can we conserve wildlife for future generations?

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Conserving Wildlife Resources

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES

1. Begin the problem area with an interest approach that includes an overview of what is to be discussed.

2. Refer to Information Sheet #1 to discuss terminology related to the problem area.

3. Using Information Sheet #2 and Transparency Master #1, discuss "Why We Should Save Wildlife."

4. Discuss how air pollution, insecticides, and solid waste disposal, when in excess, can endanger wildlife and all other living things.

5. Have students conduct a short research study and develop a paper on either air pollution, insecticides, or solid waste disposal. Refer to Student Worksheets #1, #2, or #3.

6. Conduct a discussion on the difference between conservation and ecology. Refer to Information Sheet #3.

7. Using information from the World Wildlife Federation, World Wildlife Fund, National Geographic Society, Office of Endangered Species, and Illinois Department of Conservation (see references), conduct a discussion on endangered and extinct species of wildlife in Illinois, the United States, and the world.

8. Take students on a field trip to a local zoo or wildlife preserve. Have a tour guide point out and discuss endangered species.

9. Have students complete Student Worksheet #4.

10. Use Information Sheet #4 to lead the class into a discussion on the impact of humans on wildlife and their habitat.

11. Refer to Information Sheet #5 and Transparency Master #2 to discuss methods of conserving wildlife resources.

12. Show the movie *A Second Chance* (see references). Conduct a discussion and answer student questions after the movie.

13. Have students conduct a wildlife conservation study for their local area. Have students develop a plan for conducting a project to conserve wildlife. Acquire the assistance of a local extension agent.

14. Use information Sheet #6 as a resource for subject matter content on specific Illinois wildlife. This information sheet may also be used in conjunction with Student Worksheet #5 as a supervised or independent study.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Conserving Wildlife Resources

REFERENCES

*1. *Our Natural Resource.* (1982). Kircher, H.B., Wallace, D.L. 5th edition. Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

*2. *A Second Chance.* (27-minute movie). Modern Talking Picture Service, Inc., 5000 Park Street North, St. Petersburg, FL 33709.

*3. Excellent free information on wildlife, endangered species, and extinct species is available from the following sources:

   a. Office of Endangered Species, U.S. Fish and Wildlife Service, Department of Interior, Washington, DC 20240.

   b. Illinois Department of Conservation, Endangered Species Program, Wildlife Resources Division, 605 Stratton Office Building, Springfield, IL 62706.

   c. World Wildlife Fund, 1601 Connecticut Avenue NW, Washington, DC 20009.

   d. National Wildlife Federation, 1412 16th Street NW, Washington, DC 20036.

   e. National Geographic Society, Education Services, Dept. 82, Washington, DC 20036.

*Indicates highly recommended reference

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTIONAL RESOURCES

These resources are intended for use by teachers in planning and teaching the materials for this problem area and may be adapted to fit the teaching method(s) used.

INFORMATION SHEET #1 — Terms To Be Defined

INFORMATION SHEET #2 — The Need for Wildlife — Why Should We Save Wildlife?

INFORMATION SHEET #3 — Conservation vs. Ecology — What's the Difference?

INFORMATION SHEET #4 — Environmental Control by Humans

INFORMATION SHEET #5 — Conservation of Wildlife for Future Generations

INFORMATION SHEET #6 — Management of Popular Illinois Game Species

TRANSPARENCY MASTER #1 — The Need for Wildlife — Why Should We Save Wildlife?

TRANSPARENCY MASTER #2 — Conservation of Wildlife for Future Generations

INFORMATION SHEET #1

Terms To Be Defined

Conservation — preservation from loss, waste or harm.

Ecology — the science of relationships between organisms and their environments.

Endangered — wildlife whose population is so low, it is threatened with possible extinction.

Extinct — no longer existing in living form, having died out.

Habitat — the area or type of environment in which living things normally live. Providing habitat is an especially critical wildlife conservation problem.

Wildlife — plants and animals living in a natural, undomesticated state.

INFORMATION SHEET #2

The Need for Wildlife — Why Should We Save Wildlife?

1. Economic Value of Wildlife — Wildlife provides income from sales of fish and furs. Billions of dollars are generated by fishing, hunting, and other types of wildlife-related recreation.

2. Esthetic Value of Wildlife — Simply being able to enjoy nature and its beauty is a value in itself.

3. Ecological Value of Wildlife — All life is interrelated through the food chain; animals eat plants, animals eat animals, and humans consume animals.

4. Ethical Reasons — Humans should not be wasteful. We should allow our descendants to enjoy wildlife and nature.

5. Health Reasons — Many plants and animals in the wild provide sources of new medicines.

6. New Breeds of Plants and Animals — Many times when attempting to produce new breeds or varieties, we must return to the wild for new sources of genetic traits.

INFORMATION SHEET #3

Conservation vs. Ecology — What's the Difference?

Conservation — This term implies "doing something." Conservation involves education and research, but it also involves "conserving," such as setting aside wilderness areas.

Ecology — This term means the study of the environment. The study isn't always followed by action. However, many ecologists lead conservation movements.

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INFORMATION SHEET #4

Environmental Control by Humans

The endangerment and extinction of wildlife species can be attributed mainly to the actions of the human species. Peope like to modify the environment to their liking. These modifications can and have been at the expense of many other animal species. From the planning and building of major cities, to the exploitation of the American buffalo, people have contributed to the changing of the earth's environment and to the change of living things present on the earth. In the end, humans may be their worst enemy. The value of many living things will not be realized until it becomes too late.

INFORMATION SHEET #5

Conservation of Wildlife for Future Generations

1. Education and Research — Continued research into wildlife preservation and education of the general public are essential.
2. Habitat Preservation/Creation — Preservation of environments for wildlife should be maintained, as well as the creation of new areas.
3. Government Regulations and Enforcement — Stricter laws and more severe punishment for those exploiting wildlife are necessary.
4. Preservation for Open Space — More preservation and care should be undertaken of open space to be used for recreation and scientific research.
5. Sustained Use — This concept allows the use of limited natural resources, but it requires their maintenance and replenishment so that the resources do not become extinct.
6. Industry Cleanup — Continual enforcement of industry regulations to minimize pollution is necessary.
7. Planning of Land-Use — Local, state, and U.S. government planning of prime soils, forests, and wilderness areas must be undertaken to prevent exploitation by individuals and industry.

INFORMATION SHEET #6

Management of Popular Illinois Game Species

Ring-Necked Pheasants — A favorable land use pattern for pheasants consists of (a) 65-80 percent of the area in cultivated crops such as corn, soybeans, and wheat; (b) 15-30 percent in hay and rotation patures; (c) 5-10 percent in brush and woods; and (d) 3 percent or more of the total area in brushy fence rows, odd areas, and permanently protected herbaceous cover. The pheasants' greatest need in most places is for undisturbed nesting cover and good winter cover near food supplies.

Land management practices most important in improving living conditions for pheasants are the following.

1. Establish and maintain grasses or grass-legume stands on drainage ditchbanks, field borders, grassed waterways, roadsides, odd areas, pond areas, and snow traps. Use herbicides rather than mowing to control weeds or woody plants. If mowing is necessary, delay it until after small grain harvest.
2. Establish farmstead shelterbelts with snow traps.
3. Maintain cattail-covered marshes and sloughs.
4. Establish or maintain woody cover in hedgerows, odd areas, and pond areas.

Generally, the daily range does not exceed one-half mile. The seasonal range does not usually exceed one mile. Egg laying starts during the last half of April. Most hens renest if they lost their first nest. The average clutch size is 11 eggs, laid in a two-week period. Broods begin hatching in late May or early June depending upon spring weather conditions. About 10 chicks hatch from the 11 eggs. Of these, about six or seven birds survive until fall.

Pheasants nest in grass more than any other cover. One-fourth to one-half of the nests are located in hay fields. Eighty percent of the nests in meadows or grain fields are found in the outer 100 feet. From 2/3 to 9/10 of nesting losses are due to mowing machines.

Pheasants find most of their foods in farm crop fields. Cultivated grains make up 81 percent of the total annual food and nearly one-half of this is corn. The most common weed seeds taken were foxtail, common ragweed, and wild buckwheat. These three form 78 percent of the weed seeds taken and six percent of the total annual food. Other food species of importance are wheat, barley, oats, rose hips, dogwood fruits, wild cherries, nannyberries, and highbush cranberries (NOTE: Pheasants appear to eat about one and one-fourth pounds of corn per bird per week).

Bobtail Quail — The bobwhite is one of the smallest (6 to 7 oz), yet one of our most important game birds. An ideal land use pattern for bobwhite would be an area with 30 to 40 percent in grassland, 40 to 60 percent in cropland, 5 to 20 percent in brushy cover, and 5 to 40 percent in woodland. The greater the interspersion of these types, the better the area for bobwhites.

Land management practices of benefit to the bobwhite quail are the following.

1. Crop rotations and good fertilization programs increase the amount and quality of quail foods produced.
2. Contour strip cropping provides interspersion of cover types.
3. Grass or grass-legume stands on drainage ditch banks and field borders provide nesting and roosting cover.
4. Woody cover in hedgerows, odd areas and pond areas provide travel and escape cover.
5. Improved pastures and regulated grazing within the carrying capacity of the land increase nesting and roosting cover.
6. Control of fire and grazing in woodlots, in residues of crop fields, and along roadsides increases the supply of food and the amount and variety of cover.
7. Shrubby or herbaceous borders around woodlots provide roof and escape cover.
8. Protected pond areas provide vitally needed water, cover, and sometimes food during drought periods

The daily movements of the bobwhite are relatively restricted, 1/8 to 1/4 mile is the daily range. The annual range rarely exceeds one mile. Egg laying generally starts in late April and early May. Egg laying requires two to three weeks. The average clutch size is 14, but varies from 7 to 30 or more eggs. The incubation period is 23 days. Three-fourths of the nests are generally located within 50 feet of roads, paths, or similar openings. The total loss for the 16-week growing-up period is generally 25-40 percent.

Quail need two primary kinds of cover, herbaceous and woody. Mixed grass and clover are preferred to alfalfa. The mixed stands are less dense. Grass-legume stands in rotations, and along ditches and field boundaries are of benefit.

The bobwhite is essentially a seed-eating bird, and therefore, croplands are important to the quail. Winter grains have good aftermath growth of weed seeds the summer after harvest. Grain fields and corn fields provide weed seeds nutritious to quail as well as waste grains. Where corn is grown for grain, it may make up 60 percent of the bobwhite's fall and winter food. Wheat, rye, soybeans, cowpeas, ragweed, bristle grass, common and Korean lespedeza, beggarweed, sunflower seeds, oak acorns, partridge pea, switch grass, grain sorghum, and vetch are all important foods for the bobwhite wherever they are found.

Cottontail Rabbits — The cottontail rabbit is the most popular small game animal in the United States. It thrives on agricultural lands where cropland, grassland, and woodland are about equally represented and well distributed. Some animals lend themselves naturally to management. The cottontail appears to be one of these.

Land management practices of benefit to cottontail rabbits are the following.

1. Establish and maintain grass or grass-legume stands on drainage ditch banks and field borders.
2. Establish or maintain woody cover in hedgerows, fencerows, odd areas, and pond areas. "Living brush piles," such as small thicket-like plantings of multiflora rose, are ideal.
3. Do not graze or burn farm woodlots. Pile brush in woodland borders.
4. Establish farmland and field windbreaks, or Christmas tree plantations. The combination of evergreens and grasses is very attractive to rabbits.
5. Maintain cattail-covered marshes and sloughs.

The annual range of cottontails seldom exceeds 20 acres. The cottontails occupy relatively small areas, and food and cover must be in comparatively close proximity.

The gestation period of the cottontail rabbit is approximately one month and a female may have as many as three to five litters during the breeding season. Four or five young per litter is average. They may be born any time of the year between February and September. The nest is a cup-shaped cavity on top of the ground, lined with grass and fur. Some preferred cover types for nesting are bluegrass, broomsedge, orchard grass, fescue, Korean lespedeza, and clover. The majority of the nests are found within 150 feet of a field's edge.

Less than 15 to 25 percent of the rabbits live longer than one year.

Protected nesting cover and winter cover are primary limiting factors for this species in the midwest agricultural areas. Brush piles and hollow logs left in protected woodlots, rock piles, small conifer clumps, and shrub thickets provide both winter and escape cover.

In most areas food is not a problem. It would be easier to list the food plants the animal will not eat than those it will eat. Apple, blackberry, dewberry, birch, maple, willow, basswood, dogwood, rose, sumac, clovers, grasses, wheat, alfalfa, and soybeans are all favored foods.

Tree Squirrels — The squirrel is generally considered the number two game mammal in the United States, ranking second only to the cottontail rabbit. The fox squirrel is largely an inhabitant of mature open hardwood woodlots, while the gray squirrel lives primarily in large relatively unbroken hardwood forests. In many areas both species may be found in the same tract of wood, though normally one population predominates.

Land management practices most important to tree squirrels are the following.

1. Control of fire and grazing in woodlands.
2. Manage woodlots and forests according to accepted forest management principles, practicing selective cutting, and leaving two or three good den trees per acre.
3. Establish and maintain farm shelterbelts, field windbreaks, and hedgerows. The daily cruising radius of fox squirrels seldom exceeds 300 yards, seasonal ranges may cover 10 acres, while the annual range is about 40 acres.

The gestation period of squirrels is approximately six weeks. There are usually two peak periods of birth, in late winter (February and March) and in summer (late July and August). Litters average two or three young.

Nests are of two types, den trees and leaf nests. Den trees are the more important affording the better protection throughout the year. There are two types of den, those used for reproduction, shelter, or escape, and those used for escape only. The latter consist of tree cavities that are too deep or too shallow or have entrances that are too large or are too damp. Contrary to popular belief, good den trees are not always abundant, particularly in more extensive forests.

The food and cover for tree squirrels is almost synonymous. The staple diet consists of mostly nut and acorns, and in the case of the fox squirrel, corn. Favored foods are hickory nuts, oak acorn, walnuts, butternuts, beachnuts, pine seeds, maple seeds, and hazelnuts. Trees in the woodland border or in woodland openings are generally better food producers because they receive more sunlight.

Mourning Doves — The mourning dove, America's most important game bird is the only native game bird that raises more than one brood a year. The dove is a distinct product of farmland and nests in every state except Alaska and Hawaii.

Land management practices most helpful to mourning doves are the following.

1. Establish farmstead shelterbelts, windbreaks and Christmas tree plantations for nesting sites.
2. Develop ponds and pits of dugouts for watering areas.
3. Establish or maintain cover in hedgerows, odd areas, and pond area.
4. Establish or maintain a border of coniferous trees around woodlots.

Generally two eggs are laid, two days apart. The eggs are hatched in two weeks, and two weeks later the young leave the nest and the process begins again. Nesting takes place from April to August. The majority of nests are in trees or shrubs. Red pine and Norway spruce are early season preferences; white elms, box elder, and soft maple are used more in the summer.

Three- to six-row field windbreaks or farmstead windbreaks near small grain and mixed farming are more valuable as nesting sites than single rows located in pasture fields.

Seeds compose 98 percent of the mourning dove's diet. Agricultural crops in the form of waste grains and weed seeds compose the major source of food. At least 300 plant foods are utilized. Some of the major species are corn, wheat, bristlegrass, crabgrass, ragweed, pokeweed, buckwheat, turkey mullein, fiddleneck, hemp, croton, wild beans, timothy, and Korean lespedeza.

White-Tailed Deer — The white-tailed deer is the most popular and abundant big game animal in the United States. While the white-tail is generally thought to be a product of forested lands, it often maintains higher densities and productivity where cropland, grassland, and second growth woodlands are well distributed. Intensive farming areas, however, may limit deer populations because of the lack of suitable cover and the crop damage experienced by some farmers. Most Illinois areas are now experiencing some overpopulation and deer are ranging into previously uninhabited areas, such as suburban parks and urban preserves.

Land management practices of benefit to deer are the following.

1. Protect woodlands from grazing and uncontrolled fires.
2. Reseed and renovate pastures.
3. Graze pastures within carrying capacities.
4. Fertilize and lime pastures.
5. Clear small areas in larger woodlands.
6. Plant field windbreaks and hedgerows as well as woody cover in odd areas and around ponds or other areas to provide resting sites and travel lanes.
7. Pond and pit construction will provide desired watering places.

Deer herd control (adequate harvest) is essential in order to achieve successful land management of this species.

Contrary to popular belief, white-tailed deer do not travel far. Almost 80 percent will travel less than six miles during one year.

Fawns are born in late May or June with fawns representing 30 to 40 percent of the herd by hunting season. Less than one-tenth of the deer population exceeds an age of 5 1/2 years.

SOURCE: *More Wildlife for Recreation,* U.S. Department of Agriculture, Soil Conservation Service.

TRANSPARENCY MASTER #1

The Need for Wildlife — Why Should We Save Wildlife?

1. Economic Value of Wildlife
2. Esthetic Value of Wildlife
3. Ecological Value of Wildlife
4. Ethical Reasons
5. Health Reasons
6. New Breeds of Plants and Animals

TRANSPARENCY MASTER #2

Conservation of Wildlife for Future Generations

1. Education and Research
2. Habitat Preservation/Creation
3. Government Regulations and Enforcement
4. Preservation for Open Space
5. Sustained Use
6. Industry Cleanup
7. Planning of Land-Use

STUDENT ACTIVITIES

STUDENT WORKSHEET #1 — Air Pollution

STUDENT WORKSHEET #2 — Insecticides

STUDENT WORKSHEET #3 — Solid Waste Disposal

STUDENT WORKSHEET #4 — Wildlife Conservation Word Search (with solution)

STUDENT WORKSHEET #5 — Management of Popular Illinois Game Species

For additional activities, teachers may refer to the "Suggested Teaching Activities and Procedures" section in the Instructor's Guide.

STUDENT WORKSHEET #1

Air Pollution

Write a one-page paper discussing your view of the effects of *air pollution* on all living things. Use at least one reference.

STUDENT WORKSHEET #2

Insecticides

Write a one-page paper discussing your view of the effects of *insecticides* on all living things. Use at least one reference.

STUDENT WORKSHEET #3

Solid Waste Disposal

Write a one-page paper discussing your view of the effects of *solid waste disposal* on all living things. Use at least one reference.

STUDENT WORKSHEET #4

Wildlife Conservation Word Search

G	V	P	I	P	G	A	Z	B	A	R	T	S	R	J	E	G	Z	J	N
M	T	E	Z	S	P	E	C	I	E	S	E	A	S	N	S	D	Y	F	J
I	E	C	L	V	W	D	M	I	P	C	Q	B	T	B	P	G	D	X	Z
N	J	O	Q	H	E	N	C	C	R	R	N	X	G	I	O	K	G	O	X
R	W	N	Y	Y	N	V	U	U	O	E	E	L	E	L	B	S	O	W	G
X	E	C	N	N	K	N	O	N	R	N	P	S	O	Z	T	A	E	X	R
J	L	E	I	F	O	S	O	U	O	P	S	C	E	N	H	B	H	W	B
U	D	R	I	N	E	I	T	P	E	I	E	E	E	R	B	B	U	G	U
Q	F	N	T	R	S	U	T	X	R	J	T	M	R	W	V	B	P	R	K
S	T	E	H	M	F	E	T	U	T	E	N	A	U	V	A	E	W	E	S
C	Q	D	B	V	T	I	C	Z	L	O	S	E	V	F	E	S	Y	Y	A
S	L	A	M	I	N	A	T	T	R	L	N	E	S	R	R	B	T	X	R
Z	V	W	C	C	Y	N	M	I	I	D	O	E	R	Q	E	J	E	E	R
M	O	Q	T	N	R	N	V	F	A	C	G	P	F	V	E	S	Q	V	E
L	C	C	V	H	B	N	A	N	S	Q	I	X	F	I	A	M	N	Y	R
M	K	C	O	W	E	J	G	T	E	X	M	D	T	K	L	T	E	O	Y
Q	H	F	X	W	U	E	N	V	U	R	R	Z	E	G	M	D	I	K	C
Q	X	U	X	A	R	K	P	W	J	R	B	U	D	S	J	Y	L	O	X
N	Y	F	I	E	R	M	T	I	G	H	E	W	R	M	B	L	L	I	N
U	W	K	D	X	R	G	Z	A	E	U	V	Q	A	J	Y	O	M	O	W

The following words are hidden in the puzzle:

Animals
Concerned
Conservation
Ecology
Endangered
Environment
Extinct
Future
Habitat
Insecticides

Nature
Pollution
Preservation
Preserve
Resources
Species
Waste
Wildlife
Zoo

STUDENT WORKSHEET #4 — Key

Wildlife Conservation Word Search

•	•	•	•	•	•	•	•	•	•	•	T	S	•	•	•	•	•	•	•
•	•	•	•	S	P	E	C	I	E	S	E	A	•	•	•	•	Y	•	•
•	•	C	•	•	•	•	•	•	P	C	•	•	T	•	•	G	•	•	Z
•	•	O	•	•	•	•	•	C	R	R	•	•	•	I	O	•	•	O	•
•	•	N	•	•	•	•	•	U	O	E	E	•	•	L	B	•	O	•	•
•	•	C	•	N	•	•	O	N	R	N	•	S	O	•	T	A	•	•	•
•	•	E	I	•	O	S	•	U	O	•	S	C	E	N	•	•	H	•	•
•	•	R	•	N	E	I	T	P	E	I	E	E	E	R	•	•	•	•	•
•	•	N	•	R	S	U	T	X	R	•	T	M	R	W	V	•	•	•	•
•	•	E	•	•	F	E	T	U	•	E	N	A	•	V	A	E	•	•	•
•	•	D	•	•	•	I	C	•	L	O	S	E	V	•	E	S	•	•	•
S	L	A	M	I	N	A	•	T	R	L	N	E	•	R	•	•	T	•	•
•	•	•	•	C	•	•	•	I	I	D	O	E	R	•	E	•	•	E	•
•	•	•	T	•	•	N	V	•	A	C	•	P	F	V	•	S	•	•	•
•	•	•	•	•	•	N	A	N	•	•	I	•	•	I	A	•	N	•	•
•	•	@	•	•	E	•	G	T	•	•	•	D	•	•	L	T	•	O	•
•	•	•	•	•	•	E	•	•	U	•	•	@	E	•	•	D	I	•	C
•	•	•	•	•	R	•	•	•	•	R	•	•	•	S	•	•	L	O	•
•	•	•	•	E	•	•	•	•	•	•	E	•	•	•	•	•	•	I	N
•	•	•	D	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	W

The following words are hidden in the puzzle:

Animals
Concerned
Conservation
Ecology
Endangered
Environment
Extinct
Future
Habitat
Insecticides

Nature
Pollution
Preservation
Preserve
Resources
Species
Waste
Wildlife
Zoo

STUDENT WORKSHEET #5

Management of Popular Illinois Game Species

1. A favorable land-use pattern for pheasants would consist of:
   a. _______ % of the area in cultivated crops,
   b. _______ % of the area in hay and rotation pasture,
   c. _______ % of the area in brush and woods,
   d. _______ % of the area in brushy fence rows and their permanent cover.

2. The seasonal range of pheasants generally does not exceed _________ mile(s).

3. Pheasants generally nest in ____________ in the outer ___________ feet of a field.

4. Most pheasant losses are due to ________________ .

5. List five common food sources for pheasants:
   a. __________________________
   b. __________________________
   c. __________________________
   d. __________________________
   e. __________________________

6. The ideal land-use pattern for bobwhite quail would be:
   a. _______ % grassland
   b. _______ % cropland
   c. _______ % brushy cover
   d. _______ % woodlands

7. The annual range of bobwhite quail rarely exceeds _______________ mile(s).

8. The bobwhite quail starts laying eggs in ______________________ . __________ eggs are generally laid and are incubated in ___________ days.

9. Generally ___________ % of quail are lost during the 16-week growing-up period.

10. Quail require ________________ and _______________ cover.

11. List five common seed sources for quail feed:
    a. __________________________
    b. __________________________
    c. __________________________
    d. __________________________
    e. __________________________

12. _____________ , _________________ , and ______________ should be about equally represented and well distributed for cottontail rabbits.

13. The annual range of cottontails seldom exceeds __________ acres.

14. Less than __________ % of rabbits live more than a year.

15. Protected __________________ and ______________ are the primary limiting factors for the cottontail rabbit in the midwest agricultural areas.

16. List five food sources for rabbits:

    a. ______________________________
    b. ______________________________
    c. ______________________________
    d. ______________________________
    e. ______________________________

17. Where are fox and gray squirrel generally found?

    ____

    ____

18. The annual range of squirrels is about __________ acres.

19. List the two types of squirrel nest and the two types of squirrel den:

    a. ______________________ a. ______________________
    b. ______________________ b. ______________________

20. The two main foods of squirrels are ________________ and ____________ .

21. The mourning dove nests from ______________ to ______________ and generally lays __________ eggs which hatch ___________ weeks later.

22. ____________ compose 98% of the mourning dove's diet.

23. List five common seed sources for the mourning dove's diet:

    a. ______________________________
    b. ______________________________
    c. ______________________________
    d. ______________________________
    e. ______________________________

24. The most popular and abundant big game species in Illinois is the ______________ .

25. List two limitations of white-tailed deer populations in extensive farming areas.

    a. __________________________________
    b. __________________________________

26. Most deer travel less than ____________ miles in a year.

STUDENT WORKSHEET #5 — Key

Management of Popular Illinois Game Species

1. A favorable land-use pattern for pheasants would consist of:

   a. _65-80_ % of the area in cultivated crops,
   b. _15-30_ % of the area in hay and rotation pasture,
   c. _5-10_ % of the area in brush and woods,
   d. _3_ % of the area in brushy fence rows and their permanent cover.

2. The seasonal range of pheasants generally does not exceed _1_ mile(s).

3. Pheasants generally nest in _grass_ in the outer _100_ feet of a field.

4. Most pheasant losses are due to _mowing_ .

5. List five common food sources for pheasants:

   a. _Corn_
   b. _Foxtail_
   c. _Common Ragweed_
   d. _Wild Buckwheat_
   e. _Wheat_

   Other possible answers: barley, oats, rose hips, dogwood, wild cherry, nannyberries, highbush cranberries

6. The ideal land-use pattern for bobwhite quail would be:

   a. _30-40_ % grassland
   b. _40-60_ % cropland
   c. _5-20_ % brushy cover
   d. _5-40_ % woodlands

7. The annual range of bobwhite quail rarely exceeds _1_ mile(s).

8. The bobwhite quail starts laying eggs in _late April or early May_ . _7-30_ eggs are generally laid and are incubated in _23_ days.

9. Generally _25-40_ % of quail are lost during the 16-week growing-up period.

10. Quail require _herbaceous_ and _woody_ cover.

11. List five common seed sources for quail feed:

    a. _Corn_
    b. _Wheat_
    c. _Rye_
    d. _Soybeans_
    e. _Cowpeas_

    Other possible answers: ragweed, bristle grass, lespedeza, beggarweed, sunflower, oak acorns, partridge pea, switch grass, grain sorghum, vetch.

12. _Cropland_ , _grassland_ , and _woodland_ should be about equally represented and well distributed for cottontail rabbits.

13. The annual range of cottontails seldom exceeds *20* acres.

14. Less than *15-25* % of rabbits live more than a year.

15. Protected *nesting cover* and *winter cover* are the primary limiting factors for the cottontail rabbit in the midwest agricultural areas.

16. List five food sources for rabbits:

   a. *Apple*
   b. *Blackberry*
   c. *Dewberry*
   d. *Birch*
   e. *Maple*

Other possible answers: Willow, basswood, dogwood, rose, sumac, clovers, grassses, wheat, alfalfa, soybeans.

17. Where are fox and gray squirrel generally found?
The fox squirrel is largely an inhabitant of mature open hardwood woodlots, while the gray squirrel lives mostly in unbroken hardwood forests.

18. The annual range of squirrels is about *40* acres.

19. List the two types of squirrel nest and the two types of squirrel den:

   a. *Den trees*
   b. *Leaf nests*

   a. *Those for reproduction, shelter and escape*
   b. *Those for escape only*

20. The two main foods of squirrels are *nuts* and *acorns* .

21. The mourning dove nests from *April* to *August* and generally lays *2* eggs which hatch *2* weeks later.

22. *Seeds* compose 98% of the mourning dove's diet.

23. List five common seed sources for the mourning dove's diet:

   a. *Corn*
   b. *Wheat*
   c. *Bristle grass*
   d. *Crabgrass*
   e. *Ragweed*

Other possible answers: Pokeweed, buck wheat, turkey mullein, fiddleneck, hemp, croton, wild beans, timothy, lespedeza.

24. The most popular and abundant big game species in Illinois is the *White-tailed deer* .

25. List two limitations of white-tailed deer populations in extensive farming areas.

   a. *Lack of suitable cover*
   b. *Crop damage*

26. Most deer travel less than *six* miles in a year.

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Caring for Animals

RELATED PROBLEM AREAS:

1. Maintaining Animal Health
2. Understanding Animal Anatomy and Physiology
3. Meeting Nutritional Needs of Animals
4. Meeting the Environmental Requirements of Animals

PREREQUISITE PROBLEM AREA(S):

1. Basic Principles of Animal Science (Central Core Cluster)

LEVEL: Preparatory

OCCUPATIONAL TASKS ADDRESSED:

Agricultural Business and Management Cluster

Duty A: Formulating Livestock Feeding Programs

1. Identify feed formula for livestock needs
2. Balance rations
3. Substitute feed ingredients
4. Mix feed additives and ingredients
5. Analyze feed nutritional value
6. Evaluate feeding program
7. Plan feeding program

Duty N: Breeding, Handling, and Caring for Animals

1. Assist young to nurse
2. Castrate animals
3. Dehorn animals
4. Control building temperature
5. Control building ventilation
6. Control building lighting

Duty O: Maintaining Animal Health

1. Inspect animals for disease
2. Identify ailments in animals
3. Administer medication
4. Control parasites (external or internal)
5. Treat wounds
6. Disinfect buildings and equipment
7. Deworm animals

STATE GOALS FOR LEARNING:

In planning the instruction for this problem area, teachers can promote the development of several student learning objectives which are related to the State Goals for Learning in Biological and Physical Sciences. These objectives are listed on the Learning Assessment Plan forms included on the following page(s). Those learning objectives marked with an asterisk (*) are taken from the sample lists provided by the Illinois State Board of Education.

Illinois Agricultural Core Curriculum
Agricultural Education 124 Mumford Hall 1301 W. Gregory Drive University of Illinois Urbana, IL 61801

Director: Dale A. Law, Ed.D.
Principal Investigator: Jerry D. Pepple, Ed.D.
Research Assistant: Randy J. Bernhardt

Submission Date ____________________
☐ Original submission ☐ Revision
Page ____ of ____

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☒ Sciences ☐ Physical Development/Health

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)

COUNTY	DISTRICT	ESC

District Name

City

II. STATE GOAL FOR LEARNING
As a result of their schooling, students will have a working knowledge of the concepts and basic vocabulary of biological, physical, and environmental sciences and their application to life and work in contemporary technological society.

Contact Person: ____________________
Title: ____________________
Phone: ( )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
1. Understand types of digestive systems and kinds of feeds eaten.					
*2. Understand the use of nutrients in the body.					
3. Understand feeds and nutrient needs for livestock.					
4. Describe how to evaluate feedstuffs.					
5. Prepare feeds according to select standards and balance feed rations.					
6. Compare commercial feeds and home-mixed feeds.					
7. Understand the concept of weaning.					
8. Describe and perform dehorning, castrating, and docking of animals.					
9. Explain functions, finds, and amount of bedding for animals.					
10. Understand the requirements of animal facilities and equipment.					
11. Describe the importance of pollution control when managing animal wastes.					
12. Recognize differences between good health and ill health.					
13. Understand the concept of genetic disease resistance.					
*14. Understand the principle of cause and effect as it applies to disease.					
15. Understand the basic facts about animal diseases and parasites.					
16. Develop an understanding of plants that are poisonous to animals.					
17. Explain general sanitation and disease prevention of animals.					
18. Develop an understanding of a general program of animal health, disease prevention, and parasite controls.					

Agricultural Business and Management
Animal Science

Caring for Animals

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Caring for Animals

STUDENT LEARNING OBJECTIVES

Upon completion of their study of this problem area, students will be able to:

1. Understand types of digestive systems and kinds of feeds eaten.
2. Understand the use of nutrients in the body.
3. Understand feeds and nutrient needs for livestock.
4. Describe how to evaluate feedstuffs.
5. Prepare feeds according to select standards and balance feed rations.
6. Compare commercial feeds and home-mixed feeds.
7. Understand the concept of weaning.
8. Describe and perform dehorning, castrating, and docking of animals.
9. Explain functions, kinds, and amount of bedding for animals.
10. Understand the requirements of animal facilities and equipment.
11. Describe the importance of pollution control when managing animal wastes.
12. Recognize differences between good and poor health.
13. Understand the concept of genetic disease resistance.
14. Understand the principle of cause and effect as it applies to disease.
15. Understand the basic facts about animal diseases and parasites.
16. Develop an understanding of plants that are poisonous to animals.
17. Explain general sanitation and disease prevention of animals.
18. Develop an understanding of a general program of animal health, disease prevention, and parasite control.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Caring for Animals

PROBLEMS AND QUESTIONS FOR STUDY

1. Why is it important to have a knowledge of animal feeding?
2. Define the terms herbivore, carnivore, and omnivore.
3. Compare digestive systems of a cow and a pig.
4. Define the terms energy, minerals, nutrient, protein, and vitamins.
5. What are the functions of minerals?
6. What macro- and microminerals are most important for animals?
7. What are the needs, functions, and sources of certain vitamins?
8. What are the common methods of evaluating feedstuffs?
9. What are the common methods of preparing roughage?
10. Define feed standards.
11. Define balanced ration.
12. What is (are) the difference(s) between commercial feeds and home mixed feeds?
13. Define weaning.
14. What is the normal weaning age of different animal species?
15. What are the common ways of dehorning, castrating, and docking of animals?
16. What are the purposes of animal bedding?
17. What are the kinds and amounts of animal bedding?
18. Explain the requirements of animal bedding?
19. What are the requirements of animal equipment?
20. What are the concerns associated with animal waste management and pollution control?
21. Describe the signs of good health.
22. Describe the signs of ill health.
23. What is genetic disease resistance?
24. List and describe diseases common to animals.
25. List and describe parasites common to animals.
26. List common plants poisonous to animals.
27. What management practices would develop a sanitary environment to prevent diseases in animals?
28. Develop a general program of animal health, disease prevention, and parasite control for any type of animal.

INSTRUCTOR'S NOTES AND REFERENCES

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INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Caring for Animals

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES

1. Begin the problem area with an interest approach which includes an overview of what is to be discussed.
2. Discuss the importance of having a knowledge of animal feeding. Refer to Information Sheet #1.
3. Refer to Information Sheet #2 for definitions of terms related to animal feeding.
4. Have students complete Student Worksheet #1.
5. Refer to Transparency Master #1 and Information Sheet #2 for a comparison of various animal digestive systems.
6. Have students complete Student Worksheet #2.
7. Have students read pages 226-233 of *The Stockman's Handbook* (see references) as supervised study. Discuss microminerals, macrominerals, and vitamins. Refer also to Transparency Master #2.
8. Have students complete Student Worksheets #3 and #4.
9. For supervised study, have students read pages 234-248 of *The Stockman's Handbook.* Conduct a class discussion on methods of evaluating feedstuffs.
10. Refer to Information Sheet #4 in discussing common methods of preparing roughages.
11. Discuss the difference(s) between commercial feed and home mixed feed. Refer to Information Sheet #5.
12. Take students on a field trip to a local grain elevator. Have an employee discuss and show the methods of formulating and mixing feeds.
13. Discuss animal science terminology. Refer to Information Sheet #6.
14. Using Transparency Master #3, discuss weaning age of various animal species.
15. Discuss methods and equipment used for dehorning, castrating, and docking. Refer to Transparency Master #4 and Information Sheet #7.
16. Have a veterinarian visit the class and discuss procedures involved with dehorning, castrating, and docking.
17. Using Information Sheet #8, discuss purposes, types, and amounts of bedding for animals.
18. What are the requirements of animal facilities? Use Transparency Master #5 to help students answer this question.
19. What are the requirements of animal equipment? Use Transparency Master #6 to help students answer this question.
20. Conduct a classroom discussion on pollution problems created by animal waste. Discuss possible solutions also.
21. Refer to Information Sheet #9 in discussing signs of good health.
22. Inform students that signs of ill health in animals are usually a departure from the signs of good health. Give examples of opposite indications by referring to signs of good health.
23. Refer to pages 876-916 of *The Stockman's Handbook* in discussing diseases common in your area. Have students complete Student Worksheet #5 as you progress through this topic area.
24. Refer to pages 920-960 of *The Stockman's Handbook* in discussing parasites common in your area. Have students complete Student Worksheet #6 as you progress through this topic area.

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Caring for Animals

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES (Con't.)	INSTRUCTOR'S NOTES AND REFERENCES
25. Refer to pages 962-979 of *The Stockman's Handbook* in discussing plants poisonous to animals. Have students complete Student Worksheet #7 as you progress through this topic area.	
26. Discuss animal sanitation and disease prevention. Refer to Information Sheet #10.	
27. Refer to Transparency Master #7 in discussing a program for animal health, disease prevention, and parasite control.	

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INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Caring for Animals

REFERENCES **INSTRUCTOR'S NOTES AND REFERENCES**

*1. *The Stockman's Handbook.* (1983). Ensiminger, M.E. 6th edition. Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

*2. *Animal Science.* (1983). Ensiminger, M.E. 8th edition. Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

*3. *Modern Livestock and Poultry Production.* (1983). Gillespie, J.R. 2nd edition. Delmar Publishers, Inc., 2 Computer Dr. - W., Box 15-015, Albany, NY 12212.

4. *Scientific Farm Animal Production.* (1983). Bogart, Ralph, Taylor, Robert E. 2nd edition. Burgess Publishing Company, Minneapolis, MN.

*5. A variety of free movies on livestock marketing and futures markets is available from the following sources:

Modern Talking Picture Service
Scheduling Center
5000 Park Street, N.
St. Petersburg, FL 33709-2254

Venard Films Ltd.
Peoria, IL 61654

*Indicates highly recommended reference

INSTRUCTIONAL RESOURCES

These resources are intended for use by teachers in planning and teaching the materials for this problem area and may be adapted to fit the teaching method(s) used.

INFORMATION SHEET #1 — Knowledge of Animal Feeding

INFORMATION SHEET #2 — Animal Feeding Terminology

INFORMATION SHEET #3 — The Digestive System

INFORMATION SHEET #4 — Common Methods of Preparing Roughage

INFORMATION SHEET #5 — Commercial vs. Home-Mixed Feeds

INFORMATION SHEET #6 — Animal Science Terminology

INFORMATION SHEET #7 — Dehorning, Castrating, and Docking Guide

INFORMATION SHEET #8 — Purposes, Kinds, and Amounts of Bedding

INFORMATION SHEET #9 — Animal Sanitation and Disease Prevention

TRANSPARENCY MASTER #1 — Animal Digestive Systems

TRANSPARENCY MASTER #2 — Micro- and Macrominerals and Vitamins

TRANSPARENCY MASTER #3 — Weaning Age of Various Animal Species

TRANSPARENCY MASTER #4 — Dehorning, Castrating, and Docking Methods

TRANSPARENCY MASTER #5 — Requirements of Animal Facilities

TRANSPARENCY MASTER #6 — Requirements of Animal Equipment

TRANSPARENCY MASTER #7 — A Program for Animal Health, Disease Prevention, and Parasite Control

INFORMATION SHEET #1

Knowledge of Animal Feeding

1. Development of Genetic Possibilities

   Animals inherit genetic potential, but environment, especially feeding, determines how well these genetic possibilities develop.

2. Conversion of Feed into Food, Clothing, Power and Recreation

   Two-thirds of feed consumed in the U.S. by animals is unsuited for human consumption. These feeds can be converted, through consumption by animals, to usable forms for human needs.

3. Major expense in Animal Production

   Feeding costs make up more than half the expense of raising animals.

INFORMATION SHEET #2

Animal Feeding Terminology

Balanced Ration — a ration that provides the proper proportions and amounts of all needed nutrients for a 24-hour period to animals.

Carnivores — feed entirely upon the flesh of other animals.

Energy — required for nearly all life processes. A diet must contain carbohydrates, proteins, and fats to provide adequate energy.

Feed Standards — tables showing the amounts of one or more nutrients needed by different animal species for different reasons, such as maintenance, growth, and reproduction. Most standards are stated in (a) percent of ration, and/or (b) quantity of nutrients needed daily.

Herbivores — depend entirely upon plants for feed.

Minerals — inorganic elements of plants and animals, which perform the following functions:

1. Provide strength to the skeletal system.
2. Assist in formation of muscles, organs, blood cells, and other soft body tissues.
3. Activate enzymes.
4. Control osmotic pressure and excretion.
5. Maintain acid-base balance.
6. Assist the actions of vitamins.

Nutrients — chemical substances found in feed materials that are essential for maintenance, health, and production of animals.

Omnivores — consume both plants and animals.

Proteins — complex organic compounds, made mostly of amino acids, that are needed in adequate amounts for maintenance, growth, reproduction, and animal work.

Vitamins — complex organic compounds needed in small amounts for normal maintenance, growth, and reproduction.

INFORMATION SHEET #3

The Digestive System

Monogastric (Simple Stomach)

The monogastric digestive system:

1. Is the simplest of all digestive systems.
2. Is found in humans, monkeys, pigs, and dogs.
3. Is a limited-capacity digestive system.
4. Involves digestion of foods through chemicals and secretions.

Avian (Poultry)

The avian digestive system:

1. Involves no chewing.
2. Empties food directly into crop where food is stored and soaks.
3. Passes food to a gizzard, a muscular organ which contains stones or grit which function similar to teeth.

Polygastric (Ruminants)

The polygastric digestive system:

1. Has no upper incisor or canine teeth.
2. Has four stomach compartments (rumen, reticulum, omasum, and abomasum).
3. Has more space than other systems and can process large quantities of forage.
4. Involves animals chewing their cud.
5. Is found in cows, sheep, and goats.
6. Involves digestion of foods through bacteria and chemicals.

Pseudo-Ruminants

The pseudo-ruminant digestive system:

1. Is found in horses, rabbits, guinea pigs, and hamsters.
2. Is quite different from ruminant and monogastric systems.
3. Is a larger digestive system than the monogastric.
4. Uses one stomach compartment.
5. Has a smaller stomach capacity than the ruminant system.
6. Passes food very quickly through digestive system.
7. Involves less microbial activity than the ruminant system.

INFORMATION SHEET #4

Common Methods of Preparing Roughage

1. Pelleting — involves compressing forage, preceded by grinding.
2. Cubing — involves compressing long or coarsely cut hay into cubes approximately 1 1/4" square by 2" long.
3. Both pelleting and cubing:
    a. Simplify making of hay.
    b. Reduce amount of labor.
    c. Decrease loss of nutrients.
    d. Lessen costs of transportation and storage.
    e. Eliminate dust.
4. Treatment of high-cellulose feeds (rice, wheat, and barley straws, corncobs, sawdust, etc.)
    a. Soaking in sodium, potassium or ammonium hydroxide, ammonia, and high pressure steam opens fibers and allows ease of digestion.
    b. Liquid supplements (molasses, urea, vitamins, and minerals) are widely used.

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INFORMATION SHEET #5

Commercial vs. Home-Mixed Feeds

1. Home-Mixed — Producer purchases all ingredients and mixes them individually; or producer supplies bulk of feed/grain and purchases and mixes in either a commercially prepared protein supplement which includes vitamins and minerals, or a commercially formulated vitamin/mineral mixture in oil meal.

2. Commercial — Feeds are mixed by feed manufacturers. Advantages are:

   a. Price, due to quantity buying.
   b. Cost-effective and controlled mixing.
   c. Formulation of rations by scientifically trained personnel .
   d. Quality control.

Each type of feed is a good alternative. The producer must choose that one which is more cost-effective for the particular operation.

INFORMATION SHEET #6

Animal Science Terminology

Castrating — removal of the testicles.

Dehorning — removal of animal horns; preferably done at a young age.

Docking — clipping or cutting off an animal's tail.

Genetic Disease Resistance — a method of controlling or eliminating certain diseases. Certain strains or breeds of animals have genetic resistance to disease(s).

Weaning — stopping young from nursing from their mothers.

INFORMATION SHEET #7

Dehorning, Castrating, and Docking Guide

Cattle

Skill	Method	Directions	Remarks
Dehorning	Saws and Clippers	Animals to be dehorned need to be restrained or confined. Whether using saws or clippers remove 1/4 to 1/2 inch of skin around horn base along with the horn.	Saws are commonly used in the country on ranges and for hard horns of mature cattle. Saws are available that are electrically operated. Clippers are best for dehorning young cattle. Dehorning should be done using clippers or saws in early spring or late fall to avoid insect problems. Fly repellents should be applied if dehorning is done during fly season.
	Elastrator	Use on large cattle horns (2 1/2 to 6 inches long). Stretch ring over horn well below hairline. Horns take from 3 weeks to 2 months to fall off, depending on size.	Elastrator is a rubber ring made for both dehorning and castrating. It is the least desirable way of dehorning.
	Dehorning Tube and Spoon	Calves to be dehorned must be restrained. Select an implement that will fit over horn and will remove 1/4 inch of skin around the horn. Push the cutting edge into skin around horn, then push and twist. The cut will be about 1/8 to 3/8 inches deep.	Either tools could be used for calves up to 60 days old. There are a variety of sizes to accommodate the cattleman's needs. To reduce disease and infection, the tool should be cleaned between jobs.
	Chemical	Use caustic potassium hydroxide or caustic sodium hydroxide in paste, stick, or lacquer base form. The use of Vaseline is not necessary with lacquer. Apply when calf is 3 - 10 days old. Clip hair around buttons, and surround area with ring of Vaseline to protect eyes from the chemicals. Rub chemical over button until blood is present. Protect your hands while doing this.	Dehorning should be done at a young age. This will lessen weight loss, amount of equipment needed, bruising, and amount of work. It will take approximately 14 days following dehorning for animals to heal and to regain their original weight. Chemical methods of dehorning should be used with small herds where close supervision is possible. Calves should be kept away from their dams at least a couple of hours and out of the rain a day after chemical application.
	Hot Iron	Apply a hot iron to the horns of young cattle. This device is specifically designed for dehorning.	This is a bloodless method to be used on young calves during any time of the year.
Castration	Burdizzo Pincers	Throw animal. Work cord to side of scrotum. Clamp burdizzo 1 3/4 to 2 inches above testicle, hold for a couple seconds. Repeat operation of same cord at a point 1/4 inch away from first one. Repeat procedure for other testicle.	Burdizzo Pincers are a bloodless method of castration. It's important that the cord not slip out, that only one cord be clamped at a time, and that there be no interference with circulation of blood through central part of scrotum.

Skill	Method	Directions	Remarks
	Elastrator Rings	Works best on young calves under 2 months of age. Hold calf in a sitting or lying position. Push both testicles through ring and to lower end of scrotum, then release rubber ring.	Elastrator is an instrument for use in stretching a specially made rubber ring, which is placed over scrotum to castrate younger calves.
	Short Scrotum Bulls	Shorten scrotum by bringing it through a distended rubber band with elastrator when calf is 1 - 3 months old. Before band is released, move testicles near abdominal wall. Scrotum below rubber band falls off in about 3 - 4 weeks. The testicles lie close to abdominal wall and animal is sterile. Testicles then develop to approximately half the weight of those from fertile bulls of the same age and weight.	Short scrotum method doesn't change the temperament or urge of animal. There will be riding if males and females are not kept apart. Shortening scrotum requires less time than castration. Can be completed in about 15 seconds. Rate and efficiency of weight gains of short scrotum bulls and intact bulls are approximately the same. The carcass of a short scrotum bull is leaner than that of a steer.
	"Russian Method"	Make a cut and remove spermatozoa, leaving intact the sheathing layer that produces testosterone.	This method, originated in Russia, is now being evaluated in United States. Originators state that an animal castrated in this way will gain weight like a bull but have a carcass like a steer.
	Slitting Scrotum Down Sides	Pull one testicle down. Hold firmly to outside so skin of scrotum is tight over testicle. Using a sharp knife, make a cut on the outside of scrotum next to animal's leg. It's important that cut extend down to end of scrotum to allow for proper drainage, and that the cut extend through both scrotum and membrane. It can be removed along with the testicle. Removal of all or a major part of the membrane eliminates the chance of blood collecting on it and forming a clot. Remove testicles by pulling them out. In older cattle, excessive bleeding can be prevented by scraping the partially withdrawn cord with a knife until it is cut or by clamping with an emasculator.	This method is best done when calves are 4-11 weeks old, and during early spring or late fall to avoid fly infestations. Young animals are usually thrown to be castrated, while animals 8 months or older may be easily castrated while standing. Keep hands and tools sterile and clean. Castrating at older ages will allow for higher weight gains of animals and lessen the hazard of urinary problems after castration.
	Removal of Lower End of Scrotum	Remove lower third of scrotum, exposing testicles below. Slit membrane covering testicles. The membrane doesn't have to be slit; simply remove it with the testicle. Removing a substantial portion of the membrane eliminates the chance of blood collecting on it and forming a clot. Remove testicles by pulling them. Cords may be pulled on claves with animals up to 3 - 4 months old; emasculators should be used with older bulls and calves.	Except in small calves, castration infection has been linked with removal of lower end of scrotum. This is due to bottom of scrotum curling up and stopping drainage. Sides of remaining scrotum could be slit up to body to assist in drainage.

Sheep

Skill	Method	Directions	Remarks
Docking	Hot Iron	Heat instruments only to a very dull red. Protect the lamb's buttocks. Sever tail quickly. Avoid any more burning than is necessary to prevent bleeding.	Use of hot iron instruments results in less loss of blood and less danger of infection than the use of a knife. the wound, however, heals much more slowly.
	Shears or Knife	Press skin near body before docking, leaving some loose skin above cut. This will close over wound. With smaller flocks, some producers tie a string or place a rubber band around tail before cutting. This prevents loss of blood. If done, the string or band should be removed 3 - 4 hours later. Dock tail at place desired, usually an inch from body.	Lambs should be docked at 7 - 14 days of age. Healthy lambs can be docked and castrated at the same time. Castration should be done first. Keep instruments and hands disinfected and clean. The lamb is held with its back to the assistant. The assistant grasps the hind and front legs on the same side in both hands.
	Burdizzo Pincers	Close pincers over tail at the point at which it's to be severed. Cut tail off inside closed jaws.	Burdizzo pincers are a bloodless method.
	Elastrator	Draw tail through ring. Release rubber ring at point desired.	Elastrator is a bloodless method of docking. Rubber band cuts off blood supply.
	Emasculator	Close emasculator over tail at point at which it's to be severed.	Emasculator crushes part of the tissue while cutting. This lowers the loss of blood.
Castration	Elastrator	Press both testicles through ring, down to lower end of scrotum. Release rubber ring.	Elastrator is a bloodless method of castration.
	Burdizzo Pincers	Work cord to side of scrotum. Clamp Burdizzo on above the testicle. It is held for a few seconds. Repeat procedure on other testicle.	Burdizzo pincers are a bloodless method of castration. The testicles are made functionless through destroying channels of nourishment.
	Short Scrotum Rams	See "short scrotum bulls."	Best time for castration is when lambs are 1 - 3 months old.
	Knife	Hold lamb with its back to assistant. The assistant grasps the hind and front legs of same side in both hands. Grasp tip of scrotum. Hold it tight while cutting off lower third. Draw out testicles together with the surrounding membranes.	All male lambs should be castrated when 7 - 14 days old. Healthy lambs may be castrated and docked at the same time. Keep instruments and hands disinfected and clean.

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Swine

Skill	Method	Directions	Remarks
Castration	Knife	Restrain young pigs by either holding pig by hind legs with back to assistant, while assistant's knees are clamped against pig's ribs, near pig's shoulders; or holding pig on its back on top of a table (which method requires a castration crate or two assistants, one to grasp front legs and one the rear legs). Restrain large boars by snaring around upper jaw and behind tusks, and tying free end of snare to a post. Further restrain by either tying all legs or hoisting hind legs. Castrate animal in a standing or lying poisition. Disinfect hands and knife; wash and disinfect a dirty scrotum. Slit scrotum on each side with sharp knife. Extend both cuts down to allow for proper drainage. Cut to extend through scrotum and membrane. Pull cord out or break cord off. Use an emasculator on older boars. Apply an insecticide repellent during insect season.	Male pigs for nonbreeding purposes should be castrated while they are suckling dams and far in advance of weaning. Castration should be done within 4 weeks of age, but not at the same time as the vaccination of pigs. Pigs should be kept off feed a short time before castration.

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INFORMATION SHEET #8

Purposes, Kinds, and Amounts of Bedding

1. Bedding provides:
   a. Comfort.
   b. Soaking up of urine.
   c. Easier handling of manure.
   d. Absorption of plant nutrients.

2. Kinds of bedding:
   a. Wood Products — sawdust, shavings, tree bark, chips, etc.
   b. Cut straw
   c. Peat Moss — most valuable bedding in terms of plant nutrients per ton of air-dried matter.

3. Amount of bedding:
   a. Minimum amount is that which completely absorbs the liquids in manure.

INFORMATION SHEET #9

Animal Sanitation and Disease Prevention

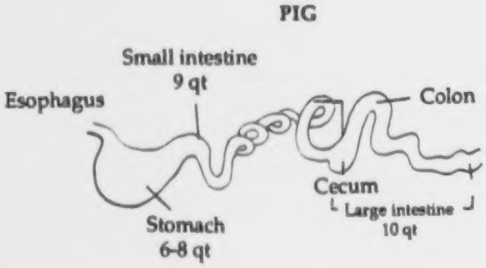
1. Ventilation:
   - a. Is important when animals are housed.
   - b. Provides movement of air.
   - c. Prevents the excessive humidity which would allow easy transmission of disease.
2. Housing should provide:
   - a. Good drainage and dryness.
   - b. Ample space.
   - c. Good lighting.
   - d. Ability, through careful construction, for easy disinfection.
3. Waste disposal involves:
   - a. Removal of excrement which can contain disease-producing agents.
   - c. Removing excrement frequently.
4. Carcass disposal should:
   - a. Not be done until after the veterinarian's examination to determine cause of death.
   - b. Be accomplished by burning, or burying at least 4 feet deep.

TRANSPARENCY MASTER #1

Animal Digestive Systems

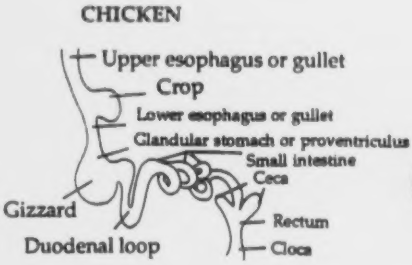
Group 1 — Monogastric (simple stomach):

Animal	*Class of Food*
Pig	Omnivore
Dog	Carnivore
Monkey	Omnivore
Man	Omnivore


PIG
Small intestine
9 qt
Esophagus
Colon
Cecum
Large intestine
10 qt
Stomach
6-8 qt

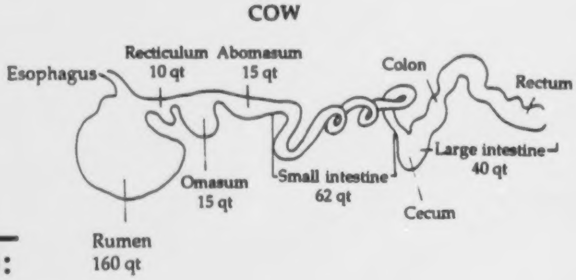
Group 2 — Avian (poultry):

Animal	*Class of Food*
Chicken	Omnivore
Turkey	Omnivore
Duck	Omnivore
Goose	Omnivore


CHICKEN
Upper esophagus or gullet
Crop
Lower esophagus or gullet
Glandular stomach or proventriculus
Small intestine
Ceca
Gizzard
Rectum
Duodenal loop
Cloca

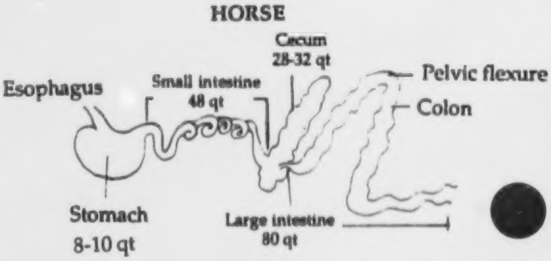
Group 3 — Polygastric (ruminants):

Animal	*Class of Food*
Cow	Herbivore
Sheep	Herbivore
Goat	Herbivore


COW
Esophagus
Recticulum
10 qt
Abomasum
15 qt
Colon
Rectum
Large intestine
40 qt
Omasum
15 qt
Small intestine
62 qt
Cecum
Rumen
160 qt

Group 4 — Pseudo-ruminants (functional cecum):

Animal	*Class of Food*
Horse	Herbivore
Rabbit	Herbivore
Guinea pig	Herbivore
Hamster	Omnivore


HORSE
Cecum
28-32 qt
Esophagus
Small intestine
48 qt
Pelvic flexure
Colon
Stomach
8-10 qt
Large intestine
80 qt

TRANSPARENCY MASTER #2

Micro- and Macrominerals and Vitamins

Microminerals

(trace elements)

Copper
Zinc
Iodine
Cobalt
Iron
Selenium
Manganese

Macrominerals

(needed in larger amounts)

Sodium Chloride (salt)
Magnesium
Calcium
Sulfur
Phosphorus

Vitamins

Vitamin A (Carotene)
Vitamin D
Vitamin E (Tocopherols)
Vitamin K
B Vitamins
Vitamin C (Ascorbic Acid)

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TRANSPARENCY MASTER #3

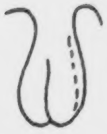
Weaning Age of Various Animal Species

Species	Weaning Age
Calves	6-8 months
Foals	4-6 months
Lambs	5 months
Pigs	5-8 weeks

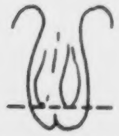
TRANSPARENCY MASTER #4

Dehorning, Castrating, and Docking Methods

Castrating Cattle

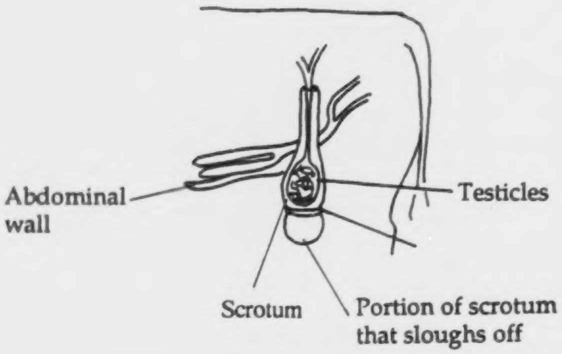


Side slit next to leg

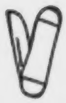


Lower third of scrotum cut off

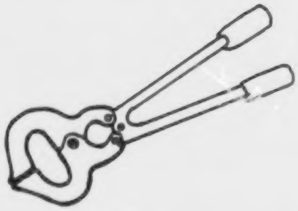
Short Scrotum Bull


Abdominal wall
Testicles
Scrotum
Portion of scrotum that sloughs off

Knife

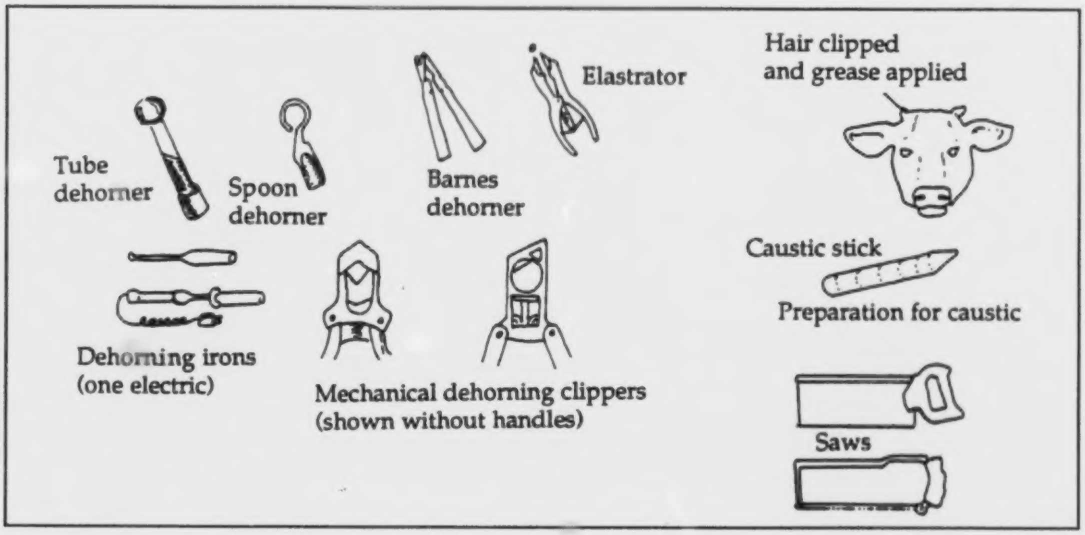


Burdizzo



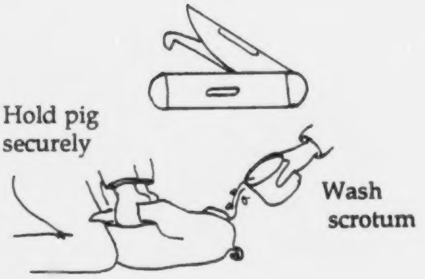
Common methods of castrating cattle, and two common pieces of cattle castrating equipment (knife and burdizzo). In using the knife, either the scrotum may be slit down the sides or the lower third may be removed. With the burdizzo, the cord is worked to the sides of the scrotum, and then the instrument is clamped on about 1-1/2" to 2" above the testicle, where it is held for a few seconds.

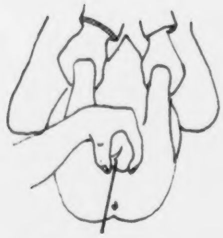
Cattle Dehorning Equipment

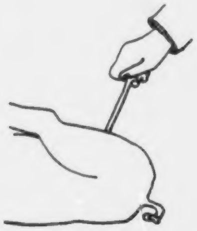

Tube dehorner
Spoon dehorner
Barnes dehorner
Elastrator
Hair clipped and grease applied
Caustic stick
Preparation for caustic
Dehorning irons (one electric)
Mechanical dehorning clippers (shown without handles)
Saws

Dehorning, Castrating, and Docking Methods

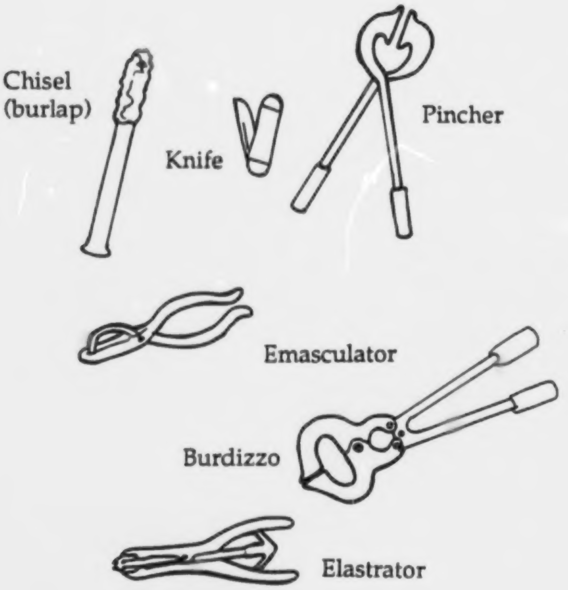
Castrating Swine


Hold pig securely
Wash scrotum

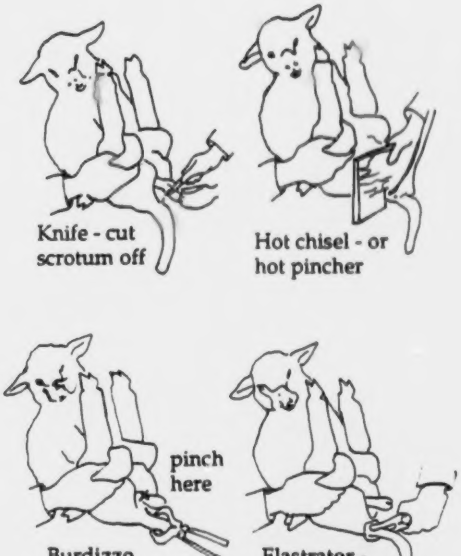

Slit scrotum


Pull testicle and cord out, breaking off well forward

Castrating Lambs


Chisel (burlap)
Knife
Pincher
Emasculator
Burdizzo
Elastrator

Common Instruments Used for Docking and Castrating Lambs


Knife - cut scrotum off
Hot chisel - or hot pincher
pinch here
Burdizzo
Elastrator - place band on scrotum in same manner

Methods of Docking and Castrating Lambs

TRANSPARENCY MASTER #5

Requirements of Animal Facilities

1. Environmental Control
2. Insulation
3. Proper Ventilation
4. Maintenance of Correct Humidity
5. Reasonable Costs for Construction and Maintenance
6. Multiple-use Building
7. Minimum Labor Needs
8. Design to Serve Intended Use
9. Protection for Newborns
10. Attractive Appearance
11. Durable Construction
12. Dry Animal Beds
13. Good Lighting
14. Allowance for Direct Sunlight
15. Sanitation
16. Easy Cleaning
17. Convenient Setup
18. Ample Space for Animals
19. Ample Space for Feeding and Bedding
20. Minimum Fire Risk
21. Safety
22. Control of Pests
23. Possible Use for Future Needs
24. Provision for Animal Health Protection

TRANSPARENCY MASTER #6

Requirements of Animal Equipment
(regardless of the type of animal or equipment)

1. Usefulness, practicality, efficiency
2. Simple construction
3. Strength and durability
4. Little need of repair
5. Low cost and low maintenance
6. Mobility, moveability
7. Easy access
8. Saving of feed
9. Reduction of labor

TRANSPARENCY MASTER #7

A Program for Animal Health, Disease Prevention, and Parasite Control

The following is applicable to most animals:

1. Provide good housing with good ventilation.
2. Keep facilities emptied one month per year (allows thorough cleaning and disinfecting).
3. Provide feeding containers.
4. Control rodents and birds (exterminate if necessary).
5. Isolate new animals from the herd (prevent introduction of new disease).
6. Don't allow commercial animal trucks near facilities.
7. Be careful when showing animals.
8. Use disinfectants.
9. Contact your veterinarian.

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STUDENT ACTIVITIES

STUDENT WORKSHEET #1 — Animal Feeding Worksheet

STUDENT WORKSHEET #2 — Animal Digestive Systems

STUDENT WORKSHEET #3 — Minerals and Vitamins

STUDENT WORKSHEET #4 — Minerals and Vitamins Word Search

STUDENT WORKSHEET #5 — Diseases of Animals

STUDENT WORKSHEET #6 — Parasites of Animals

STUDENT WORKSHEET #7 — Common Poisonous Plants

For additional activities, teachers may refer to the "Suggested Teaching Activities and Procedures" section in the Instructor's Guide.

STUDENT WORKSHEET #1

Animal Feeding Worksheet

Answer the following questions:

1. List and explain two reasons why it is important to have a knowledge of feeding animals.

2. Give four functions of minerals.

Match each term in the left column with its correct description below.

1. _____ Balance Ration
2. _____ Carnivores
3. _____ Energy
4. _____ Feed Standards
5. _____ Herbivores
6. _____ Minerals
7. _____ Nutrients
8. _____ Omnivores
9. _____ Protein
10. _____ Vitamins

A. A ration that provides to animals the proper proportions and amounts of all needed nutrients for a 24-hour period.

B. Consume both plants and animals.

C. Inorganic elements of plants and animals.

D. Chemical substances found in feed materials that can be used and are essential for maintenance, health, and production of animals.

E. Required for nearly all life processes. A diet must contain carbohydrates, proteins, and fats to provide an adequate amount.

F. Show the amounts of one or more nutrients needed by different animal species for different reasons, such as maintenance, growth, and reproduction. Most are stated in (a) percent of ration, and/or (b) quantity of nutrients needed daily.

G. Complex organic compounds made mostly of amino acids. Needed in adequate amounts for maintenance, growth, reproduction, and animal work.

H. Complex organic compounds needed in small amounts for normal maintenance, growth, and reproduction.

I. Feed entirely upon the flesh of other animals.

J. Depend entirely upon plants for feed.

STUDENT WORKSHEET #1 — Key

Animal Feeding Worksheet

Answer the following questions:

1. List and explain two reasons why it is important to have a knowledge of feeding animals.

   See Information Sheet #2.

2. Give four functions of minerals.

   See Information Sheet #2.

Match each term in the left column with its correct description below.

1. *A* Balance Ration
2. *I* Carnivores
3. *E* Energy
4. *F* Feed Standards
5. *J* Herbivores
6. *C* Minerals
7. *D* Nutrients
8. *B* Omnivores
9. *G* Protein
10. *H* Vitamins

A. A ration that provides to animals the proper proportions and amounts of all needed nutrients for a 24-hour period.

B. Consume both plants and animals.

C. Inorganic elements of plants and animals.

D. Chemical substances found in feed materials that can be used and are essential for maintenance, health, and production of animals.

E. Required for nearly all life processes. A diet must contain carbohydrates, proteins, and fats to provide an adequate amount.

F. Show the amounts of one or more nutrients needed by different animal species for different reasons, such as maintenance, growth, and reproduction. Most are stated in (a) percent of ration, and/or (b) quantity of nutrients needed daily.

G. Complex organic compounds made mostly of amino acids. Needed in adequate amounts for maintenance, growth, reproduction, and animal work.

H. Complex organic compounds needed in small amounts for normal maintenance, growth, and reproduction.

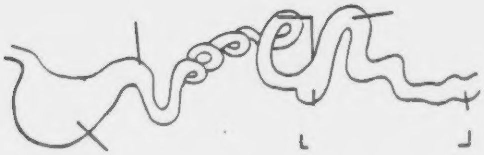
I. Feed entirely upon the flesh of other animals.

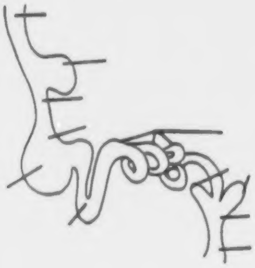
J. Depend entirely upon plants for feed.

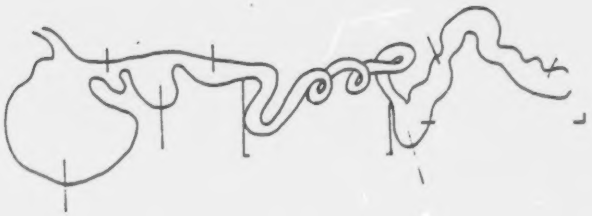
STUDENT WORKSHEET #2

Animal Digestive Systems

Label system as simple, ruminant, or avian. Label all parts of each digestive system.







In the space provided below, discuss similarities and differences among simple, ruminant, and avian digestive systems.

STUDENT WORKSHEET #3

Minerals and Vitamins

Match the term in the left column with its correct classification in the right column.

1. ____ Ascorbic Acid
2. ____ Calcium
3. ____ Carotene
4. ____ Cobalt
5. ____ Copper
6. ____ Iodine
7. ____ Iron
8. ____ Magnesium
9. ____ Manganese
10. ____ Phosphorus
11. ____ Selenium
12. ____ Sodium Chloride
13. ____ Sulfur
14. ____ Tocopherols
15. ____ Zinc

A. Macromineral

B. Micromineral

C. Vitamin

STUDENT WORKSHEET #3 — Key

Minerals and Vitamins

Match the term in the left column with its correct classification in the right column.

1. *C* Ascorbic Acid
2. *A* Calcium
3. *C* Carotene
4. *B* Cobalt
5. *B* Copper
6. *B* Iodine
7. *B* Iron
8. *A* Magnesium
9. *B* Manganese
10. *A* Phosphorus
11. *B* Selenium
12. *A* Sodium Chloride
13. *A* Sulfur
14. *C* Tocopherols
15. *B* Zinc

A. Macromineral

B. Micromineral

C. Vitamin

STUDENT WORKSHEET #4

Minerals and Vitamins Word Search

X	E	N	K	N	E	S	E	N	A	G	N	A	M	P	Z	E	X	R	J
L	F	O	P	S	E	L	E	N	I	U	M	H	B	W	M	B	U	D	I
B	B	A	U	G	U	Q	R	U	F	L	U	S	F	A	M	T	J	B	P
R	K	S	S	E	T	V	H	M	V	T	U	W	C	E	I	S	C	Q	B
V	T	C	L	Z	N	F	I	I	Y	R	Y	R	A	T	C	S	I	R	B
X	R	O	Z	O	V	E	T	T	E	W	O	C	Y	N	R	R	M	Q	J
E	R	R	S	M	R	A	T	P	A	M	O	Q	N	R	O	F	G	E	Q
V	E	B	L	O	M	E	P	O	I	M	T	C	C	N	M	V	H	B	S
Q	X	I	F	I	D	O	H	N	R	L	I	M	Y	R	I	M	K	C	O
W	J	C	N	M	C	I	E	P	A	A	E	N	X	M	N	T	K	E	Y
Q	H	A	F	X	U	R	U	B	O	C	C	W	D	U	E	N	V	R	R
Z	G	C	M	K	A	I	O	M	A	C	S	Q	X	U	R	X	A	K	P
W	J	I	B	L	U	C	S	L	C	D	O	N	J	Y	A	X	N	Y	F
I	R	D	S	M	T	I	C	E	G	H	H	T	I	W	L	R	M	B	L
L	U	W	K	X	R	I	G	I	N	Z	L	A	E	M	S	U	V	Q	A
J	Y	O	M	O	U	D	J	I	O	G	G	Q	I	U	A	A	N	U	D
E	W	V	D	M	D	I	J	W	E	D	A	Q	R	C	J	T	E	M	M
W	Z	R	G	S	F	P	V	I	U	D	I	M	V	I	N	W	I	U	L
Y	I	P	H	O	S	P	H	O	R	U	S	N	D	O	D	I	P	V	N
D	X	V	L	T	G	L	U	Q	D	I	U	V	E	B	F	E	Z	K	B

The following words are hidden in the puzzle:

Ascorbic Acid
B Vitamins
Calcium
Carotene
Cobalt
Copper
Iodine
Iron
Macrominerals
Magnesium
Manganese
Microminerals
Phosphorus
Selenium
Sodium Chloride
Sulfur
Tocopherols
Vitamin
Vitamin D
Zinc

STUDENT WORKSHEET #4 — Key

Minerals and Vitamins Word Search

•	•	•	•	•	E	S	E	N	A	G	N	A	M	•	•	•	•	•	•
•	•	•	•	S	E	L	E	N	I	U	M	•	•	•	M	•	•	•	•
•	•	A	•	•	•	•	R	U	F	L	U	S	•	A	M	•	•	•	•
•	•	S	•	E	•	V	•	•	V	•	•	•	C	•	I	•	•	•	•
•	•	C	L	•	N	•	I	I	•	R	•	R	•	•	C	•	I	•	•
•	•	O	•	O	•	E	T	T	E	•	O	•	•	•	R	R	•	•	•
•	•	R	S	•	R	A	T	P	A	M	•	•	•	•	O	•	•	•	•
•	•	B	•	O	M	E	P	O	I	N	T	•	•	N	M	•	•	•	•
•	•	I	•	I	D	O	H	N	R	L	I	•	•	•	I	•	•	•	•
•	•	C	N	M	C	I	E	P	A	A	•	N	•	•	N	•	•	•	•
•	•	A	•	•	U	R	U	B	O	C	C	•	D	•	E	•	•	•	•
•	•	C	•	•	A	I	O	M	A	C	S	•	•	•	R	•	•	•	•
•	•	I	•	L	•	C	S	L	C	•	O	N	•	•	A	•	•	•	•
•	•	D	S	•	•	•	C	E	•	H	•	T	I	•	L	•	•	•	•
•	•	•	•	•	•	I	•	I	N	•	L	•	•	M	S	•	•	•	•
•	•	•	•	•	U	•	•	•	O	G	•	O	•	•	A	•	•	•	•
•	•	•	•	M	•	•	•	•	•	D	A	•	R	C	•	T	•	•	•
•	•	•	•	•	•	•	•	•	•	•	I	M	•	I	N	•	I	•	•
•	•	P	H	O	S	P	H	O	R	U	S	N	•	•	D	I	•	V	•
•	•	•	•	•	•	•	•	•	•	•	•	•	E	•	•	E	Z	•	B

The following words are hidden in the puzzle:

Ascorbic Acid
B Vitamins
Calcium
Carotene
Cobalt
Copper
Iodine
Iron
Macrominerals
Magnesium
Manganese
Microminerals
Phosphorus
Selenium
Sodium Chloride
Sulfur
Tocopherols
Vitamin
Vitamin D
Zinc

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STUDENT WORKSHEET #5

Diseases of Animals

Complete this worksheet as diseases are discussed in class.

Disease	Species Affected	Cause	Symptoms and Signs	Treatment	Prevention

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STUDENT WORKSHEET #6

Parasites of Animals

Complete this worksheet as parasites are discussed in class.

Parasite	Species Affected	Symptoms and Signs	Treatment	Prevention and Control

STUDENT WORKSHEET #7

Common Poisonous Plants

Complete this worksheet as poisonous plants are discussed in class.

Common Name	Description of Plant	Where it grows	Species Affected	Conditions When Poisoning Occurs	Toxic Symptoms	Treatment	Prevention

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Identifying Career Opportunities in Animal Science

RELATED PROBLEM AREAS:

1. Identifying Career Opportunities in Agribusiness Management

PREREQUISITE PROBLEM AREA(S): None

LEVEL: Orientation

OCCUPATIONAL TASKS ADDRESSED:

Agricultural Business and Management

Duty R: Applying Safety Practices

1. Comply with shop and equipment safety rules
2. Apply basic emergency first aid techniques
3. Complete accident report
4. Inspect work area and equipment for safe working environment
5. Use fire extinguisher
6. Correct safety hazards
7. Demonstrate cardiopulmunary resuscitation (CPR) techniques
8. Comply with safety requirements for working
9. Participate in safety training program

STATE GOALS FOR LEARNING:

In planning the instruction for this problem area, teachers can promote the development of several student learning objectives which are related to the State Goals for Learning in Biological and Physical Sciences. These objectives are listed on the Learning Assessment Plan forms included on the following page(s). Those learning objectives marked with an asterisk (*) are taken from the sample lists provided by the Illinois State Board of Education.

Illinois Agricultural Core Curriculum

Agricultural Education 124 Mumford Hall 1301 W. Gregory Drive University of Illinois Urbana, IL 61801

Director: Dale A. Law, Ed.D.
Principal Investigator: Jerry D. Pepple, Ed.D.
Research Assistant: Randy J. Bernhardt

88/89
Agricultural Business and Management
Animal Science

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date ____________
☐ Original submission ☐ Revision
Page ____ of ____

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☒ Sciences ☐ Physical Development/Health

(Affix label or complete district information.)
COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐
District Name
City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will have a working knowledge of the social and environmental implications and limitations of technological development.

Contact Person: ____________
Title: ____________
Phone: ( )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
1. Understand career opportunities in the field of animal science.					
2. Understand educational requirements for animal science careers.					
*3. Identify careers in which scientific training is important.					
4. Research an animal science career and develop a career research paper.					
801					802

ISBE 41-78 (1/88)

Agricultural Business and Management
Animal Science

Identifying Career Opportunities in Animal Science

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Identifying Career Opportunities in Animal Science

STUDENT LEARNING OBJECTIVES

Upon completion of their study of this problem area, students will be able to:

1. Understand career opportunities in the field of animal science.
2. Understand educational requirements for animal science careers.
3. Research an animal science career and develop a career research paper.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Identifying Career Opportunities in Animal Science

PROBLEMS AND QUESTIONS FOR STUDY

1. What are some careers in the field of animal science?
2. What are the educational requirements for careers in animal science?
3. How does one develop a career research paper?
4. Research an animal science career. Answer the following questions in your research paper: What are the educational requirements? What are the employment opportunities in this field? What are the working conditions? What level of salary can one expect in this career? Where can a person expect to work? What are the advancement opportunities?

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Identifying Career Opportunities in Animal Science

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES

INSTRUCTOR'S NOTES AND REFERENCES

1. Begin problem area with an interest approach that includes an overview of what is to be discussed.

2. Have students list possible careers in the animal science field. Use Information Sheet #1 to assist in discussion.

3. Have a school counselor discuss the educational requirements for various careers in animal science.

4. Show the movie *Today's Veterinarian* (see references). This movie discusses many different careers in the animal sciences field. Conclude movie with a classroom discussion, and answer any student questions.

5. Have students complete Student Worksheet #1.

6. Invite several guest speakers who work in animal science careers to talk to the class about their work.

7. Have students complete Student Worksheet #2.

8. Have students conduct a career research paper on a career in animal science. Their paper should answer the following questions: What are the educational requirements? What are the employment opportunities? What are the working conditions? Where would I work or for whom would I work? What level of salary can I expect to earn? What opportunities are there for career advancement?

9. Information Sheet #2 provides addresses of Illinois community colleges and universities. Students may wish to write to some of the institutions for information on animal science careers and educational requirements.

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Identifying Career Opportunities in Animal Science

REFERENCES

INSTRUCTOR'S NOTES AND REFERENCES

*1. *Careers in Agribusiness and Industry*. (1980). Stone, Stone, and Gulvin. Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

2. *Essential Aspects of Career Planning and Development*. (1977). Atherton, J.C., Mumphrey, A. Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

*3. *Jobs? What They Are . . . Where They Are . . . What They Pay!* (1985). Snelling, R.O., Snelling, A.M. Simon and Schuster, Inc., Simon and Schuster Building, Rockefeller Center, 1230 Avenue of the Americas, New York, NY 10020.

*4. *Today's Veterinarian*. (18-minute film). Modern Talking Picture Service, Inc., 5000 Park Street North, St. Petersburg, FL 33709.

*Indicates highly recommended reference

INSTRUCTIONAL RESOURCES

These resources are intended for use by teachers in planning and teaching the materials for this problem area and may be adapted to fit the teaching method(s) used.

INFORMATION SHEET #1 — Careers in the Animal Science Field

INFORMATION SHEET #2 — Community Colleges and Universities in Illinois

INFORMATION SHEET #1

Careers in the Animal Science Field

1. Production Worker
2. Ranch Manager
3. Veterinary Assistant
4. Veterinarian
    a. Companion Animal Veterinarian
    b. Production Animal Veterinarian
    c. Combination Companion and Production Animal Veterinarian

5. Educator
6. Extension Specialist
7. Animal Researcher
8. Geneticist

INFORMATION SHEET #2

Community Colleges and Universities in Illinois

Community Colleges

Belleville Area College
2500 Carlyle Road
Belleville, IL 62221

Black Hawk College, East Campus
P.O. Box 489
Kewanee, IL 61443

Carl Sandburg College
P.O. Box 1407
2232 S. Lake Storey Road
Galesburg, IL 61401

Danville Area Community College
200 East Main Street
Danville, IL 61832

Highland Community College
Pearl City Road
Freeport, IL 61032

Illinois Central College
East Peoria, IL 61635

Illinois Eastern Community College
Wabash Valley College
220 College Drive
Mt. Carmel, IL 62863

Illinois Valley Community College
R.R. #1
Oglesby, IL 61348

John Wood Community College
P.O. Box 419
Perry, IL 62362

Joliet Junior College
1215 Houbolt Avenue
Joliet, IL 60436

Kankakee Community College
Box 888
Kankakee, IL 60901

Kaskaskia College
Shattuc Road
Centralia, IL 62801

Kishwaukee College
Box 29
Malta, IL 60150

Lake Land College
South Route 45
Mattoon, IL 61938

Lewis and Clark Community College
5605 Godfrey Road
Godfrey, IL 62035

Lincoln College
300 Keokuk
Lincoln, IL 62656

Lincoln Land Community College
Shepherd Road
Springfield, IL 62708

McHenry County College
Route 14 and Lucas Road
Crystal Lake, IL 60014

Parkland College
2400 W. Bradley
Champaign, IL 61821

Rend Lake College
Ina, IL 62846

Richland Community College
One College Park
Decatur, IL 62526

Shawnee College
Ullin, IL 62992

Spoon River College
R.R. #1
Canton, IL 61520

Triton College
2000 5th Avenue
River Grove, IL 60171

Universities

Illinois State University
Department of Agriculture
Normal, IL 61761

Southern Illinois University
Agricultural Education and Mechanization
Carbondale, IL 62901

University of Illinois
College of Agriculture
124 Mumford Hall
1301 W. Gregory Drive
Urbana, IL 61801

Western Illinois University
Department of Agriculture
Macomb, IL 61455

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STUDENT ACTIVITIES

STUDENT WORKSHEET #1 — Animal Science Career Word Search

STUDENT WORKSHEET #2 — Job Trends

For additional activities, teachers may refer to the "Suggested Teaching Activities and Procedures" section in the Instructor's Guide.

STUDENT WORKSHEET #1

Animal Science Career Word Search

S	B	C	M	W	I	P	M	O	E	K	F	L	B	N	B	Z	Z	P	D
T	A	V	T	S	C	I	E	N	C	E	A	K	O	S	X	I	E	N	Z
I	L	E	G	C	F	U	C	F	T	I	K	I	H	H	L	G	A	V	N
J	Q	X	D	N	U	U	C	R	T	R	T	Q	Q	Y	E	Q	G	L	X
X	O	T	L	I	M	K	T	N	E	C	A	M	U	L	Q	A	M	S	X
J	K	E	R	N	X	R	E	U	U	S	U	I	L	X	O	B	L	T	F
H	E	N	V	R	O	T	W	D	R	J	E	O	N	C	A	R	L	T	J
S	I	S	R	E	O	I	O	S	P	E	C	A	L	I	Y	M	G	L	H
F	B	I	Q	P	T	R	T	L	P	I	C	W	R	C	N	T	L	M	R
Z	H	O	S	T	P	E	L	A	D	E	Y	N	D	C	G	G	V	P	I
P	G	N	A	Z	B	C	R	A	C	T	C	R	E	R	H	R	H	S	E
R	E	G	A	N	A	M	G	I	E	U	E	I	Z	I	J	N	L	M	T
E	Z	S	N	R	S	D	F	C	N	W	D	S	A	J	R	A	I	E	L
V	W	D	E	M	I	Q	H	B	A	A	B	E	C	L	M	E	P	D	X
N	J	E	Q	H	E	N	N	R	C	N	R	X	G	I	I	K	P	G	X
R	R	W	Y	Y	O	N	D	V	U	N	L	I	N	E	T	S	S	X	W
G	X	E	N	L	K	I	N	P	E	Z	E	A	A	X	R	E	T	J	E
L	F	O	O	P	N	H	B	E	W	B	U	D	I	N	B	B	N	S	U
G	U	G	Q	G	F	T	D	J	B	P	R	K	S	T	H	M	T	E	U
W	Y	E	S	C	Q	B	V	T	Z	F	Y	Y	A	T	S	R	B	X	G

The following words are hidden in the puzzle:

Animals
Career
College
Education
Experience
Extension
Future
Genetics
Health
Manager
Need
Potential
Production
Research
Rewarding
Science
Specialists
Technology
Training
Veterinarian

STUDENT WORKSHEET #1 — Key

Animal Science Career Word Search

•	•	•	•	•	•	•	•	•	•	•	•	L	•	N	•	•	•	•	•
•	•	•	•	S	C	I	E	N	C	E	A	•	O	•	•	•	E	•	•
•	•	E	•	•	F	•	•	•	T	I	•	I	•	H	•	G	•	•	•
•	•	X	•	•	•	U	•	R	T	R	T	•	•	•	E	•	•	•	•
•	•	T	•	•	•	•	T	N	E	C	A	•	•	L	•	A	•	•	•
•	•	E	•	N	•	•	E	U	U	S	•	I	L	•	•	•	L	•	•
•	•	N	V	•	O	T	•	D	R	•	E	O	N	•	•	•	•	T	•
•	•	S	•	E	O	I	O	S	•	E	C	A	•	I	•	•	•	•	H
•	•	I	•	P	T	R	T	•	P	•	C	•	R	•	N	•	•	•	•
•	•	O	•	•	P	E	•	A	•	E	•	N	•	C	•	G	•	•	•
•	•	N	•	•	•	C	R	•	C	T	C	R	E	•	H	•	•	S	•
R	E	G	A	N	A	M	•	I	E	U	E	I	•	I	•	•	L	•	•
•	•	•	•	R	•	•	•	C	N	W	D	S	A	•	R	A	•	•	•
•	•	•	E	•	•	•	H	•	A	A	•	E	C	L	M	E	•	•	•
•	•	E	•	•	•	N	•	R	•	•	R	•	•	I	I	•	P	•	•
•	R	•	•	•	O	•	D	•	•	N	•	I	N	•	T	S	•	X	•
•	•	•	•	L	•	I	•	•	E	•	•	A	A	•	•	E	T	•	E
•	•	•	O	•	N	•	•	E	•	•	•	•	•	N	•	•	N	S	•
•	•	G	•	G	•	•	D	•	•	•	•	•	•	•	•	•	•	E	•
•	Y	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	G

The following words are hidden in the puzzle:

- Animals
- Career
- College
- Education
- Experience
- Extension
- Future
- Genetics
- Health
- Manager
- Need
- Potential
- Production
- Research
- Rewarding
- Science
- Specialists
- Technology
- Training
- Veterinarian

STUDENT WORKSHEET #2

Job Trends

Job trends are often discussed in the news. Knowing job trends can assist you when making decisions about your career.

Select an article from a newspaper or magazine. Clip the article and include with this worksheet. If you have problems locating an article, consult with the school or community library.

Summarize the article and answer the questions that follow.

Job Trend Article

Article Title:

Source of Information:

Summarize the content of the article in the space below:

1. What, in your opinion, is causing this job trend?
2. Will this job trend affect you or your career decisions?
3. Can you predict what the effect will be of this job trend on goods and services you normally use?
4. Is this a short- or long-term job trend?
5. Will this trend affect others as well?

Summary Questions:

1. How can education prepare you for a future career?
2. How can reading articles about job trends affect you and your career decision?

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Economic Principles of Livestock Production

RELATED PROBLEM AREAS:

1. Applying Basic Economic Principles in Agribusiness (Central Core Cluster)
2. Marketing Agricultural Products and Services

PREREQUISITE PROBLEM AREA(S)

1. Applying Basic Economic Principles in Agribusiness (Central Core Cluster)

LEVEL: Preparatory

OCCUPATIONAL TASKS ADDRESSED:

Agricultural Business and Management Cluster

Duty D: Marketing Animals and Animal Products

1. Plan marketing schedule
2. Select markets

STATE GOALS FOR LEARNING:

In planning the instruction for this problem area, teachers can promote the development of several student learning objectives which are related to the State Goals for Learning in Social Sciences. These objectives are listed on the Learning Assessment Plan forms included on the following page(s). Those learning objectives marked with an asterisk (*) are taken from the sample lists provided by the Illinois State Board of Education.

Illinois Agricultural Core Curriculum

Agricultural Education 124 Mumford Hall 1301 W. Gregory Drive University of Illinois Urbana, IL 61801

Director: Dale A. Law, Ed.D.
Principal Investigator: Jerry D. Pepple, Ed.D.
Research Assistant: Randy J. Bernhardt

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date ____________
☐ **Original submission** ☐ **Revision**
Page ____ of ____

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☐ Mathematics ☒ Social Sciences
☐ Sciences ☐ Physical Development/Health

(Affix label or complete district information.)

COUNTY	DISTRICT	ESC

District Name

City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to understand and analyze comparative political and economic systems, with an emphasis on the political and economic systems of the United States.

Contact Person: ____________
Title: ____________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Identify factors which affect supply and demand.					
2. Understand the importance of timing of livestock sales.					
3. Understand the uses of futures markets in marketing livestock.					

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Department of School Improvement Services
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Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date ____________
☐ **Original submission** ☐ **Revision**
Page ____ of ____

(Affix label or complete district information.)

COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐
District Name
City

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☐ Mathematics ☒ Social Sciences
☐ Sciences ☐ Physical Development/Health

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to apply the skills and knowledge gained in the social sciences to decision making in life situations

Contact Person: ____________
Title: ____________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Analyze the complex relationships existing among individual consumers, business, industry, and government entities.					
2. Develop an understanding of government programs available to livestock producers.					
3. Understand methods of marketing livestock.					
4. Identify causes for a change in supply of livestock or animal products and its impact on retail prices and consumer demand.					
5. Identify causes for a change in consumer demand of livestock or animal products.					

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INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Economic Principles of Livestock Production

STUDENT LEARNING OBJECTIVES

Upon completion of their study of this problem area, students will be able to:

1. Identify factors which affect supply and demand.
2. Understand the importance of timing of livestock sales.
3. Understand the uses of futures markets in marketing livestock.
4. Analyze the complex relationships existing among individual consumers, business, industry, and government entities.
5. Develop an understanding of government programs available to livestock producers.
6. Understand methods of marketing livestock.
7. Identify causes for a change in supply of livestock or animal products and its impact on retail prices and consumer demand.
8. Identify causes for a change in consumer demand of livestock or animal products.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Economic Principles of Livestock Production

PROBLEMS AND QUESTIONS FOR STUDY

1. What is supply? What is a supply curve?
2. What is demand? What is a demand curve?
3. What could cause a change in the supply of animals or animal products?
4. What affect would a change in the supply of animal products have on retail prices and consumer demand?
5. What could cause a change in consumer demand for livestock or animal products?
6. Analyze a current or historical event that occurred in the livestock industry and relate the event's impact on supply, demand, and price.
7. What are some methods of marketing livestock?
8. Why is timing important when selling livestock?
9. What is the futures market?
10. How can a producer use the futures market when marketing livestock?
11. What are the government programs that are available to livestock producers?

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Economic Principles of Livestock Production

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES

1. Begin the problem area with an interest approach that includes an overview of what is to be discussed.

2. Conduct a classroom discussion on supply, supply curve, demand, demand curve, and market. Refer to Information Sheet #1.

3. Have students conduct a classroom discussion on changes in supply of animals and animal products. Ask the following questions: What could cause a change in the supply of animals or animal products? What effect would the change have on retail prices? What effect would the change have on consumer demand? Students should complete Student Worksheet #1 as the discussion proceeds.

4. Have students brainstorm for five minutes in response to the question, What could cause a change in consumer demand for livestock or animal products? Use Student Worksheet #2 for this activity. At the completion of the activity, have students share their ideas with the class. Compile a list on the chalkboard. Supply additional ideas students may have overlooked.

5. Have students complete Student Worksheet #3.

6. Use Transparency Master #1 to discuss different methods of marketing livestock.

7. Discuss timing of livestock sales with students. Refer to Information Sheet #2 and Transparency Masters #2 - #4.

8. Discuss with students futures contracts and livestock futures contracting. Refer to pages 313-325 of *Farm Management Guide* and/or pages 550-566 of *Business Management for Farmers* (see references).

9. Refer to Information Sheet #3 to discuss government programs for livestock producers.

10. Use selected modules from *Applied Mathematics* to develop students' skills in reading and using graphs and charts.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Animal Science

PROBLEM AREA: Economic Principles of Livestock Production

REFERENCES

*1. *Business Management for Farmers*. (1983). Looney, J.W. Doane Information Services, 11701 Borman Drive, St. Louis, MO 63146.

*2. *The Stockman's Handbook.* (1983). Ensminger, M.E. 6th edition. Interstate Publishers, Inc.,. P.O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

3. *Farm Management Guide*. (most recent edition). Doane Information Services, 11701 Borman Drive, St. Louis, MO 63146.

*4. A variety of free movies on livestock marketing and futures markets is available from the following sources:

Modern Talking Picture Service
Scheduling Center
5000 Park Street, N.
St. Petersburg, FL 33709-2254

Venard Films Ltd.
Peoria, IL 61654

5. *Applied Mathematics*. Curriculum Publications Clearinghouse, 46 Horrabin Hall, Western Illinois University, Macomb, IL 61455.

*Indicates highly recommended reference

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTIONAL RESOURCES

These resources are intended for use by teachers in planning and teaching the materials for this problem area and may be adapted to fit the teaching method(s) used.

INFORMATION SHEET #1 — Supply, Demand, and Markets

INFORMATION SHEET #2 — Timing of Livestock Sales

INFORMATION SHEET #3 — Government Programs

TRANSPARENCY MASTER #1 — Methods of Marketing Livestock

TRANSPARENCY MASTER #2 — Feeder Cattle Marketing Trends

TRANSPARENCY MASTER #3 — Slaughter Steers Marketing Trends

TRANSPARENCY MASTER #4 — Cash Hogs Marketing Trends

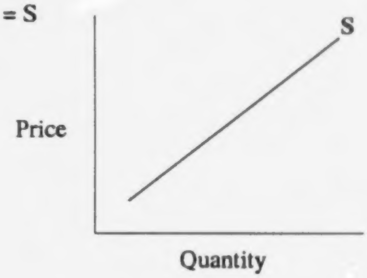
INFORMATION SHEET #1

Supply, Demand, and Markets

Market — A market is a place where buying, selling, or trading can take place.

Supply — When the price of a product lowers (assuming no change in other factors than price), less of the product will be supplied.

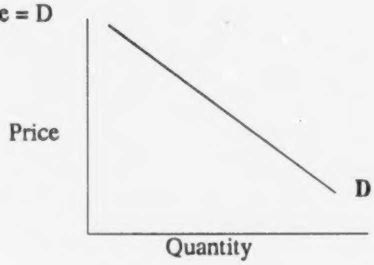
Supply curve = S



1. The curve shows different amounts producers will offer for sale at different prices.
2. As price increases, producers will offer more quantity for sale.
3. As price decreases, producers will offer less quantity for sale.
4. The curve moves upward from left to right.

Demand — When the price of a product increases (assuming no change in other factors than price), less of the product will be taken.

Demand Curve = D



1. The curve shows different amounts consumers will purchase at different prices.
2. Consumers will purchase less as price increases.
3. As price decreases, consumers will purchase more.
4. The curve moves downward from left to right.

INFORMATION SHEET #2

Timing of Livestock Sales

Two types of timing livestock sales

1. At most efficient marketing weight of animal
    a. The larger a livestock animal gets, the less efficiently it will convert feed to body weight
    b. Heavier animals may sell at a market price discount because of wasteful fat on the carcasses.
    c. The manager must determine the most efficient marketing weight to ship to market.
2. During time of peak prices
    a. Seasonal production patterns may be valuable in determining marketing plans.
    b. There are different seasonal patterns for different animal species.
    c. Timing to peak prices can assist in long run production and market planning.

Examples of Peak Prices:

Animal Science	Peak Price Period
Feeder Cattle	Late Spring-Early Summer
Slaughter Steers	January-Summer and into Winter
Hogs	April-July

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INFORMATION SHEET #3

Government Programs

Marketing Orders — The government attempts to control supply and price by measures such as price level supports to assure price stability.

Government Buyout Program — In order to reduce milk production the government began buying dairy animals from producers.

Parity and Parity Prices in Farm Animals — Parity is a means of measuring the relationship between the prices producers receive for products they sell and the prices they pay for the supplies they buy.

Government programs for grains can directly affect animal production, especially if the grain can be fed to the livestock.

TRANSPARENCY MASTER #1

Methods of Marketing Livestock

Most Livestock is Marketed Through Four Channels in the U.S.

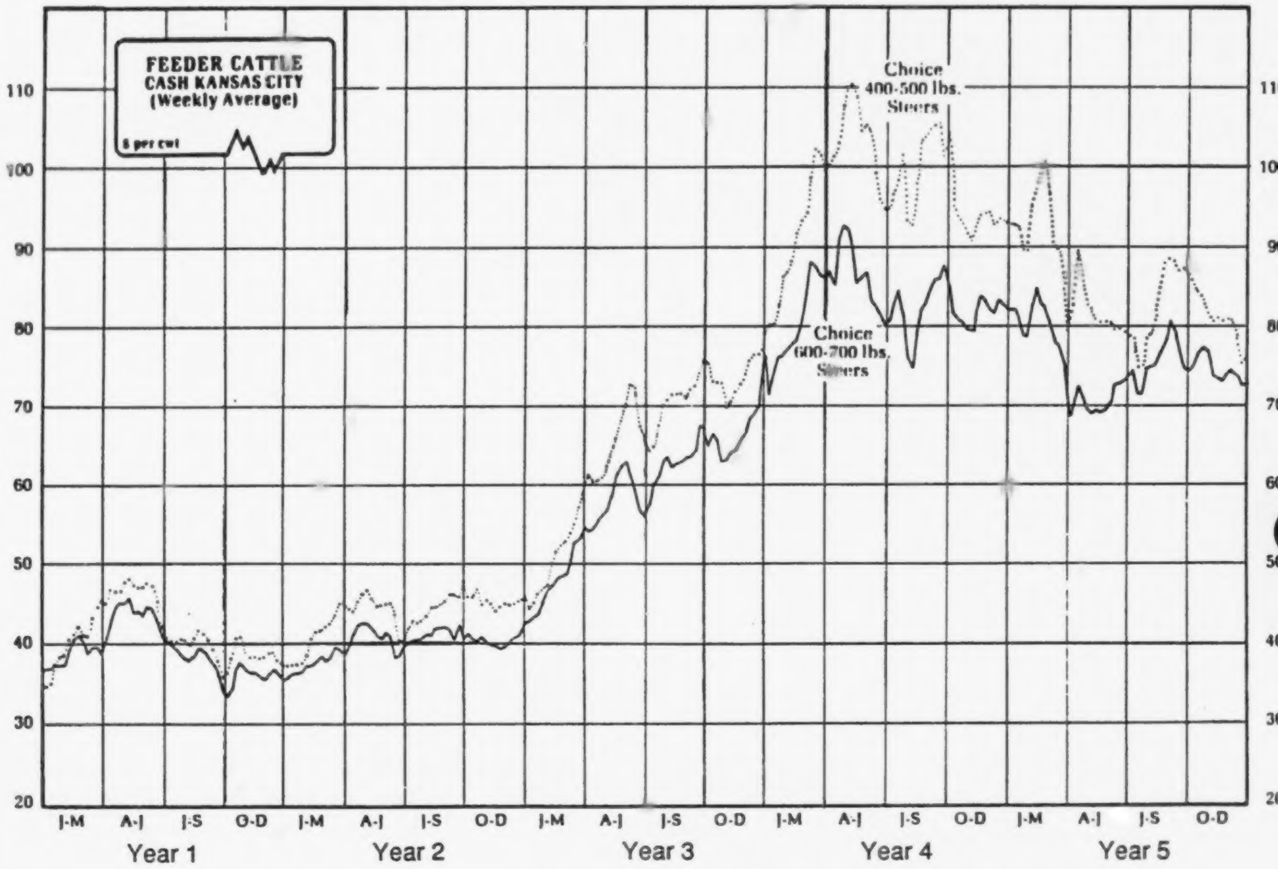
Terminals
Direct Sales
Auctions
Carcass Grade/Weight Basis

Other methods include:

County Commission Firms
Local Markets
Concentration Yards
Local Plants and Retailers
Order Buyers
Cooperative Shipping and Selling Associations
Telephone Auctions and Telephone Direct Selling
Teletype Auctions
Television Auctions
Selling on Consignment

TRANSPARENCY MASTER #2

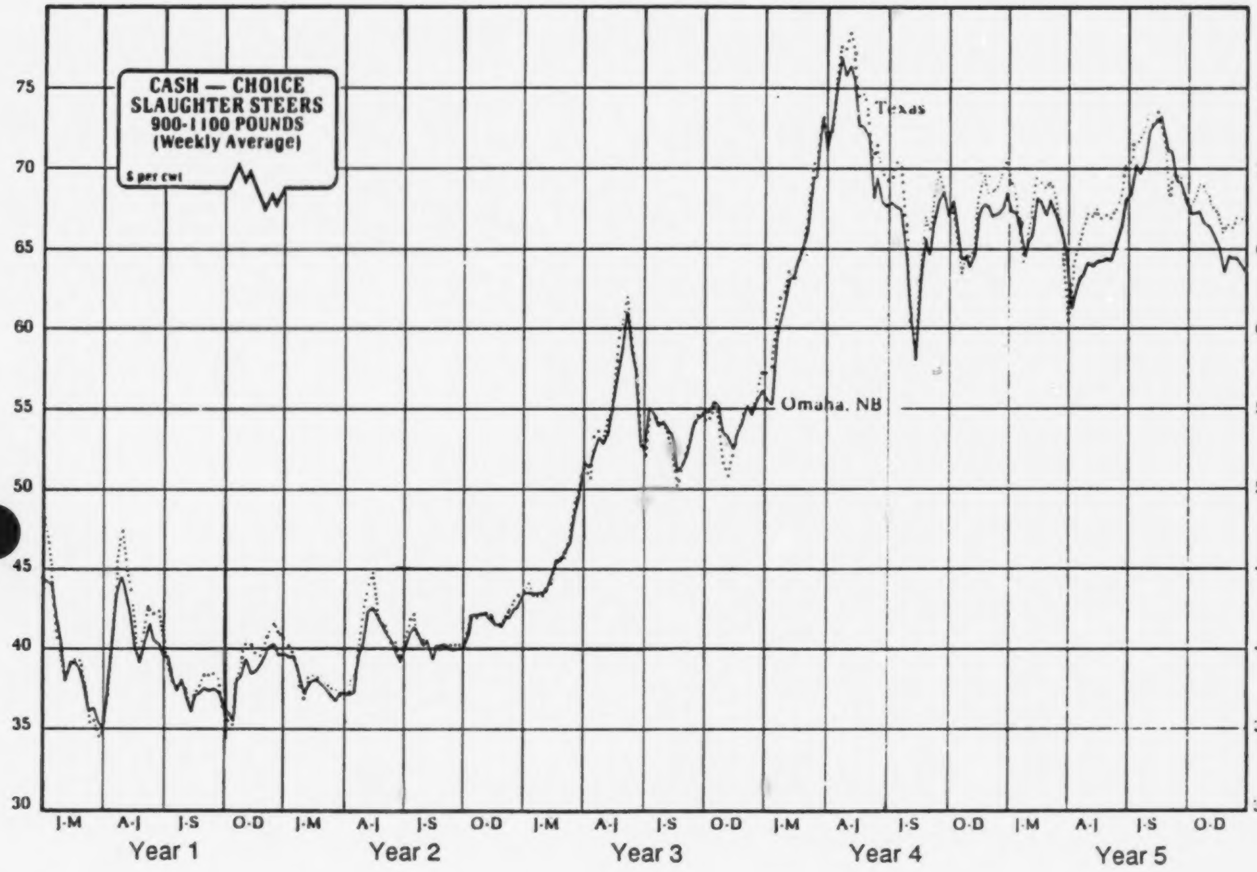
Feeder Cattle Marketing Trends



Reproduced from *Business Management for Farmers*. Looney, J.W. with permission from Doane Information Services.

TRANSPARENCY MASTER #3

Slaughter Steers Marketing Trends



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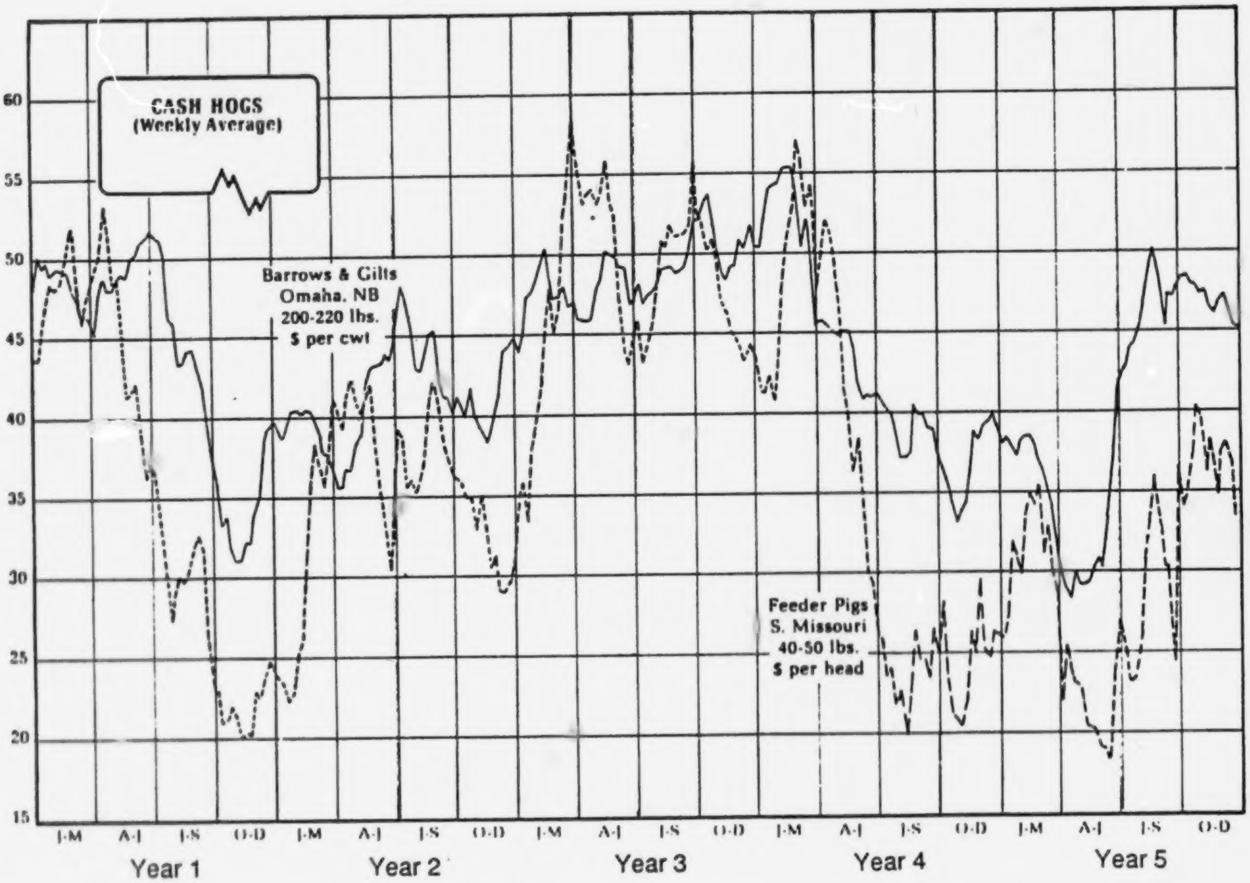
TRANSPARENCY MASTER #4

Cash Hogs Marketing Trends



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STUDENT ACTIVITIES

STUDENT WORKSHEET #1 — Changes in Supply of Animals or Animal Products

STUDENT WORKSHEET #2 — Brainstorming Activity

STUDENT WORKSHEET #3 — Livestock Industry Economics

For additional activities, teachers may refer to the "Suggested Teaching Activities and Procedures" section in the Instructor's Guide.

STUDENT WORKSHEET #1

Changes in Supply of Animals or Animal Products

Complete the worksheet during classroom discussion on supply changes (from Suggested Teaching Activities and Procedures, item 3).

Cause for Supply Change	Increase or Decrease in Supply	Effects on Price	Effects on Consumer Demand

STUDENT WORKSHEET #2

Brainstorming Activity

Directions:

Generate as many answers as you can think of for the question below. Follow directions from the instructor on when to begin and end this activity.

Question:

"What could cause a change in consumer demand for livestock or animal products?"

STUDENT WORKSHEET #3

Livestock Industry Economics

Directions:

Select an article from a newspaper or magazine discussing a current or historical event that occurred in the livestock industry. Complete the summary and answer the questions that follow. Attach article to this activity sheet.

If you have difficulty locating an article, consult your school or community library for assistance.

Title of Article: ______________________________

Source of Article: ______________________________

Summary (in the space provided, summarize the article content in your words)

Questions:

1. What effect will this event have on supply of livestock?
2. What effect will the event have on the supply of retail products that contain the animal products?
3. What effect will the event have on price of the retail good?
4. What will consumer demand be for retail goods containing the animal product?
5. Will this be a short- or long-term trend? Explain your answer.

UNIT C: Plant and Soil Science

PROBLEM AREAS:

1. Enhancing Soil Fertility
2. Preventing Soil Erosion and Managing Land
3. Classifying Soils
4. Classifying Plants
5. Propagating Plants
6. Understanding Plant Germination, Growth, and Development
7. Controlling Plant Pests
8. Maintaining Grain Quality
9. Identifying Career Opportunities in Plant and Soil Science
10. Identifying Alternative Crop Production Systems

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Enhancing Soil Fertility

RELATED PROBLEM AREA(S):

1. Understanding the Relationship Between Agriculture and the Environment (Central Core Cluster)
2. Understanding Basic Soil Science Principles (Central Core Cluster)
3. Identifying Basic Principles of Plant Science (Central Core Cluster)
4. Classifying Soils
5. Understanding Plant Germination, Growth, and Development
6. Enhancing Soil Fertility (Horticulture Cluster)

PREREQUISITE PROBLEM AREA(S):

1. Understanding Basic Soil Science Principles (Central Core Cluster)

LEVEL: Preparatory

OCCUPATIONAL TASKS ADDRESSED: None

STATE GOALS FOR LEARNING

In planning the instruction for this problem area, teachers can promote the development of several student learning objectives which are related to the State Goals for Learning in Biological and Physical Sciences. These objectives are listed on the Learning Assessment Plan forms included on the following page(s). Those learning objectives marked with an asterisk (*) are taken from the sample lists provided by the Illinois State Board of Education.

Illinois Agricultural Core Curriculum

Agricultural Education 124 Mumford Hall 1301 W. Gregory Drive University of Illinois Urbana, IL 61801

Director: Dale A. Law, Ed.D.
Principal Investigator: Jerry D. Pepple, Ed.D.
Research Assistant: Randy J. Bernhardt

839

Submission Date ____________

☐ Original submission ☐ Revision

Page ____ of ____

I. LEARNING AREA *(check one)*

☐ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☒ Sciences ☐ Physical Development/Health

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)

COUNTY	DISTRICT	ESC

District Name

City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will have a working knowledge of the social and environmental implications and limitations of technological development.

Contact Person: ____________
Title: ____________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Relate the chemical formation and effects of acid rain.					

ISBE 41-78 (1/88)

Submission Date ____________
☐ Original submission ☐ Revision
Page ____ of ____

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☒ Sciences ☐ Physical Development/Health

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)

COUNTY	DISTRICT	ESC

District Name

City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will have a working knowledge of the concepts and basic vocabulary of biological, physical, and environmental sciences and their application to life and work in contemporary technological society.

Contact Person: ____________
Title: ____________
Phone: ( )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Identify the components of soil.					
*2. Understand the importance of acids, bases, and salts in industry and the home.					
3. Define soil.					
4. Explain why soils are important.					
5. List micronutrients and macronutrients necessary for plant growth.					
6. List plant nutrient deficiency symptons.					
7. Define pH and label acid, neutral, and base on a pH scale.					
8. List pH range in which most plants survive and describe how to alter soil pH chemically.					
9. Explain a fertilizer grade.					
10. Know materials needed, the steps to follow, and number of samples to take when soil sampling.					
11. Determine fertility needs based on soil sample analysis results.					
12. Understand primary functions and limitations of soil tests.					
13. Explain the use of organic residues.					

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Enhancing Soil Fertility

STUDENT LEARNING OBJECTIVES

Upon completion of their study of this problem area, students will be able to:

1. Define soil.
2. Explain why soils are important.
3. List micronutrients and macronutrients necessary for plant growth and their influences on plant growth.
4. List plant nutrient deficiency symptoms.
5. Define pH and label acid, neutral, and base on a pH scale.
6. List pH range in which most plants survive and describe how to alter soil pH chemically.
7. Explain a fertilizer grade.
8. Know materials needed, the steps to follow, and number of samples to take when soil sampling.
9. Determine fertility needs based on soil sample analysis results.
10. Understand the primary functions and limitations of soil tests.
11. Explain the use of organic residues.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Enhancing Soil Fertility

PROBLEMS AND QUESTIONS FOR STUDY

1. What are the main components of soil?
2. What is an acid? What is a base?
3. What is soil?
4. Why are soils important?
5. What are the micronutrients that are needed for plant growth? What influence does each have on plant growth?
6. What are the macronutrients that are needed for plant growth? What influence does each have on plant growth?
7. If a nutrient is deficient, what are the symptoms that can be observed externally on a plant?
8. What is pH?
9. On a pH scale of zero to fourteen, where is acidic, basic, and neutral?
10. In what pH range can most plants generally survive?
11. How can we chemically alter soil pH?
12. What is a fertilizer grade? Explain what each of the three numbers represents.
13. What materials are needed to take a soil sample?
14. What are the steps to follow when taking a soil sample?
15. When we take a soil sample, how many samples do we take from one area?
16. How can we determine fertility needs based on a soil sample analysis?
17. What are the primary functions and limitations of soil tests?
18. Should we put organic residues to use on crop land? What benefits are there to organic fertilizers?
19. What is the chemical formation and effects of acid rain?

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Enhancing Soil Fertility

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES

1. Use an interest approach to begin the problem area. Refer to "Problems and Questions for Study." Ask students questions to help them to begin thinking about soils and soil fertility.

2. Using Transparency Master #1, explain the general composition of an average loam soil.

3. Explain the following terms: pH, acidic, alkaline (basic), pH scale. Explain neutral, alkaline (basic) range, and acidic range on the pH scale. Discuss the pH range in which most plants can survive.

4. Conduct a basic laboratory experiment on acidity - alkalinity. Using litmus paper as an indicator, test the following familiar substances (classify as either acidic or alkaline):

   Lye (pH 13.0)
   Household Ammonia (12.0)
   Milk of Magnesia (10.0)
   Baking Soda (8.5)
   Milk (7.0)
   Black Coffee (5.0)
   Tomatoes (4.0)
   Lemon Juice (2.0)

5. Ask students for a definition of soil. Conduct laboratory experiment "What's the Dirt - A Lesson in Soil Analysis," on pages 65-70 of *Agricultural Basics in Education, Classroom Lessons on Illinois Agriculture.*

6. Explain the importance of soils. Ask students if they can add to the list of reasons why soil is important.

7. Discuss the difference between micronutrients and macronutrients, and how each nutrient influences plant growth. Have students complete Student Worksheet #1.

8. Explain external observations which indicate plants are deficient in certain nutrients.

9. Have students complete Student Worksheet #2.

10. Ask students if they are familiar with plant growth problems associated with improper soil pH. What are some of these problems associated with improper soil pH? How can we alter soil pH?

11. Ask students, "What is a fertilizer grade? What does each of the three numbers represent?" After a thorough discussion, have students complete Student Worksheet #3.

12. Information Sheet #6 is provided as a service for those in need of a place to have soil samples tested.

13. Explain materials needed, steps to follow, and how many samples should be taken from one area.

14. Help students fill out a copy of the Soil Sample Information Sheet.

15. Use Vocational Agriculture Service Units to supplement soil testing unit.

16. Assist students in plotting soil sample locations on Information Sheet #9.

17. Information Sheet #10 is supplied as a guide.

18. Information Sheets #11 and #12 are supplied for urban soil testing.

19. Have students complete Student Worksheet #4.

20. By this time students should be able to soil test. Have students plot out and take actual soil tests on the school's land lab; their own farm, yard or garden; or neighbor's land (with permission). Maybe this could be done as a service to neighbors for a BOAC project.

21. Student Worksheet #5, Information Sheet #13, and Information Sheet #14 are provided for instructor to use as he or she sees fit.

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Enhancing Soil Fertility

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES (Con't.)

INSTRUCTOR'S NOTES AND REFERENCES

22. Have students complete Student Worksheets #5 and #6.

23. Discuss the uses of organic fertilizers. Ask students to list benefits of using organic fertilizers. List on the board.

24. Distribute copies of Information Sheet #16. Have students read for supervised study. Answer any student questions.

25. Have students conduct a research paper or science laboratory experiment related to information in this unit.

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INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Enhancing Soil Fertility

REFERENCES

*1. *Crop Production*. (1984). Delorit, Greub, Ahlgren. 5th edition. Prentice-Hall, Inc., Englewood Cliffs, NJ.

2. *Acid Rain - The Silent Crisis*. (1980). Weller, Phil, and the Waterloo Public Interest Research Group. The Alger Press Limited, Ontario, Canada.

3. *Acid Rain*. (Special Publication #14). (June 1985). Council for Agricultural Science and Technology, Headquarters Office, P.O. Box 1550, Iowa State University Station, Ames, IA 50010-1550. (515) 292-2125.

*4. *Our Soils and Their Management*. (1983). Donahue, Follett, Tulloch. Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050.

*5. *Agricultural Basics in Education, Classroom Lessons on Illinois Agriculture*. (1986). Lewis, John L. Project Director. Illinois Council on Economic Education, Northern Illinois University, DeKalb, IL.

*6. *pH Test for Soil Acidity* (VAS Unit #U4002A); *Testing Soil for Phosphorus* (VAS Unit #U4003B); *Determining Available Potassium in Soils* (VAS Unit #U4004B); *Agronomy Handbook*. Vocational Agriculture Service, College of Agriculture, University of Illinois, 1401 S. Maryland Drive, Urbana, IL 61801. (217) 333-3871.

7. A variety of free movies on topics relating to soil fertility is available from the following sources:

Modern Talking Picture Service
Scheduling Center
5000 Park Street, N.
St. Petersburg, FL 33709-2254

The Farm Film Foundation
1425 H Street, N.W.
Washington, DC 20005

*Indicates highly recommended reference

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTIONAL RESOURCES

These resources are intended for use by teachers in planning and teaching the materials for this problems area and may be adapted to fit the teaching method(s) used.

INFORMATION SHEET #1 — Terms to be Defined

INFORMATION SHEET #2 — Macronutrients and Their Influence on Plants

INFORMATION SHEET #3 — Micronutrients and Their Influence on Plants

INFORMATION SHEET #4 — Plant Nutrient Deficiency Symptoms

INFORMATION SHEET #5 — Improper Soil pH and Problems Associated with Improper pH

INFORMATION SHEET #6 — Soil Testing Services in Illinois

INFORMATION SHEET #7 — Directions for Collecting Soil Samples

INFORMATION SHEET #8 — Soil Sample Information Sheet

INFORMATION SHEET #9 — Map of this Field

INFORMATION SHEET #10 — Soil Sample Information Sheet — Sample

INFORMATION SHEET #11 — Suggested Instructions for Obtaining Soil Samples from Lawns, Gardens, and Ground Beds

INFORMATION SHEET #12 — Suggested Procedures for Sampling Greenhouse Soils

INFORMATION SHEET #13 — Lime, Phosphorus, and Potassium - Maps and Interpretation

INFORMATION SHEET #14 — Soil Sample Test Results

INFORMATION SHEET #15 — Organic Fertilizers

INFORMATION SHEET #16 — Acid Rain

TRANSPARENCY MASTER #1 — Volume Composition of Average Soil

TRANSPARENCY MASTER #2 — pH Scale

TRANSPARENCY MASTER #3 — Why Soils are Important

TRANSPARENCY MASTER #4 — Why Soils Become Acidic

TRANSPARENCY MASTER #5 — Fertilizer Grade

TRANSPARENCY MASTER #6 — Types of Organic Fertilizers

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INFORMATION SHEET #1

Terms to be Defined

Acidity — indicated by pH numbers below 7.

Alkalinity (basic) — indicated by pH numbers above 7.

Fertilizer grade — expressed as a set of three numbers such as 10-10-10. The numbers "5-20-20" on a fertilizer bag mean that the manufacturer guarantees that it contains (always in this order) 5 percent total nitrogen, 20 percent available phosphate (P_2O_5), and 20 percent water-soluble potash (K_2O).

Macronutrients — nutrients used by plants in large amounts.

Micronutrients — nutrients used by plants in small amounts.

pH — hydrogen ion concentration of a soil.

pH scale — a scale of measurement of the acidity or alkalinity (basic) of a soil; ranges from 0 to 14, although a range of 3 to 9 is common with most soils.

Soil — the outer portion of the earth's crust that supports the growth of plants.

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INFORMATION SHEET #2

Macronutrients and Their Influence on Plants

Primary Macronutrients

Nitrogen (N) influences plant growth in these ways:

1. Gives a dark green color to all plants.
2. Increases leaf and stem growth.
3. Assists in seed production of many grasses.
4. Increases protein content of some food and feed crops.
5. Improves quality of bread made from wheat.
6. Encourages growth of grasses in legume-and-grass mixture.
7. Decreases winter hardiness.
8. Delays maturity, decreases resistance to some insects and disease, weakens straw, increases water content, and lowers quality of some fruits and vegetables.

Phosphorus (P) reacts on plant growth in these ways:

1. Stimulates root formation and growth.
2. Hastens maturity.
3. Aids in cell division and reproduction.
4. Encourages flower development, pollination, and seed formation.
5. Increases legume growth.
6. Increases protein and mineral content of grasses and legumes.
7. Makes plants more winter-hardy.
8. Enables legumes to compete more favorably with grasses.
9. Increases percentage of phosphorus and calcium in food and feed crops.
10. Assists in legume nodule formation.

Potassium (K) affects legumes, grasses, and most other plants in these ways:

1. Imparts plant vigor and resistance to certain diseases.
2. Aids in moving foods from the leaves to the roots.
3. Favors the growth of legumes in competition with other plants.
4. Produces stiff stems and thus reduces lodging.
5. Increases grain plumpness.
6. Imparts winter hardiness.
7. Assists in transformation and translocation of sugars, starches, celluloses, and other carbohydrates.

Secondary Macronutrients

Calcium (Ca) applied to soil as calcic limestone serves these functions in the plant:

1. Promotes early root growth.
2. Improves general plant vigor and growth.
3. Encourages grain and seed production.
4. Increases stiffness of the straw in grains.
5. Maintains strength and selective permeability of cell walls.
6. Neutralizes acids produced in plants.
7. Increases the calcium content of food and feed crops.
8. Encourages nodule formation of legumes.
9. Reduces plant uptake of radioactive elements harmful to humans.
10. Regulates intake of other elements.

Magnesium (Mg) serves these purposes in plant nutrition:

1. Assists in maintaining a dark green color of leaves.
2. Regulates uptake of other plant nutrients.
3. Acts as a carrier of phosphorus in the plant.
4. Promotes the formation of oils and fats.
5. Plays a part in the movement of starch in the plant.

Sulfur (S) functions in plant growth in these ways:

1. Gives increased root growth.
2. Helps maintain dark green color.
3. Promotes nodule formation on legumes.
4. Stimulates seed production.
5. Encourages more vigorous plant growth.

INFORMATION SHEET #3

Micronutrients and Their Influence on Plants

Iron (Fe)

1. Is most important in chlorophyll formation.
2. Is active in oxidation-reduction reactions.
3. Plays a vital role in the activity of enzyme systems.

Manganese (Mn)

1. Assists, together with iron, in formation of chlorophyll.
2. Is active in carbohydrate formation.
3. Accelerates the germination of seeds and maturity of plants.
4. Is active in oxidation-reduction reactions.
5. Affects vitamin content of plants.

Zinc (Zn)

1. Is essential to the formation of chlorophyll.
2. Influences seed production and grain yield.
3. Is essential in formation of growth hormones.

Copper (Cu)

1. Acts as a regulator of several biochemical processes that occur in plants.
2. Acts as a catalyst to help route the various nutrient ions into their proper growth functions.
3. Is active in oxidation-reduction reactions.
4. In small excess, is toxic to plants.

Boron (B)

1. Is essential for pollination and reproduction.
2. Influences flower and seed formation.
3. Influences oxygen supply to plant tissues and roots.
4. Is closely related to calcium performance in plants.
5. In small excess, is toxic to plants.

Molybdenum (Mo)

1. Is essential for the Rhizobia bacteria that live in nodules on legume roots.
2. Influences the reduction of nitrate in protein synthesis.
3. Is instrumental in starch formation, amino acid formation, and vitamin formation.
4. In small excess, is toxic to plants and animals.

Chlorine (Cl)

1. Has an unknown function in plants.

INFORMATION SHEET #4

Plant Nutrient Deficiency Symptoms

Nitrogen (N) deficiency symptoms are:

1. Sickly, yellowish-green color of foliage.
2. Slow, dwarfed growth.
3. Drying up (firing) of lower bottommost leaves of plant, proceeding upward as season advances. In plants such as corn, small grains, beets, beans, and grasses, firing starts at tips of bottom leaves and proceeds along midrib (centers) of leaves toward stems.

Phosphorus (P) deficiency symptoms are:

1. Slow-growing, dwarfed plant.
2. Lower leaves purple along the margins, beginning at the tips; margins and tips of leaves may eventually die, leaving signs of "firing."
3. In the case of corn, sorghums, and small grains, the remainder of the plant having deep bluish green or purple cast.
4. Small, slender stalks in the case of corn; small grains fail to stool (new plants arising from a single plant).
5. Low grain yields, slow to mature.

Potassium (K) deficiency symptoms are:

1. Lower leaves "scorched" or "burned" on margins and tips. These dead areas may fall out, leaving ragged edges. In corn, small grains, and grasses, "firing" starts at tips of leaves and proceeds down from the edges or margins, usually leaving the midribs green.
2. Weak stalks, poor root development causing plants such as corn to break over and lodge.

Calcium (Ca) deficiency symptoms are:

1. Young leaves at the growing points (tops of the plants) becoming "hooked" in appearance and dying back at the tips and along the margins.
2. Leaves having wrinkled appearance.
3. Young leaves remaining folded in some cases.
4. Short and much-branched roots.

Magnesium (Mg) deficiency symptoms are:

1. General loss of green color which starts in bottom leaves and later moves up the stalks. The veins of the leaves remain green, thus causing a striped appearance.
2. Weak stalks with long, branched roots.
3. In corn, definite and sharply defined series of yellowing-green, light yellow, or even white streaks on all leaves throughout entire plant.
4. Leaves curving upward along the margins.

Sulfur (S) deficiency symptoms are:

1. Young leaves (uppermost leaves) light green in color, having even lighter veins. Entire plant shows a general pale yellow color.
2. Short, slender plants.
3. Slow, stunted growth.

Boron (B) deficiency symptoms are:

1. Greatest in effect on younger or bud leaves.
2. Young leaves light green color.
3. Death of terminal bud or growing point after distortion at tips and bases of young leaves.
4. Failing to set seed; high degree of barren stalks in corn.
5. Deficiency in alfalfa known as white top.
6. Deficiency in pears resulting in small corky fruit that contains cracks.
7. Hollow heart in cauliflower. The hollow stem rots and the entire plant may rot if severely deficient.

Zinc (Zn) deficiency symptoms are:

1. Greatest in effect on older or lower leaves.
2. In corn, chlorotic (yellow to white) stripes on each side of the midribs, especially on lower and middle leaves of the plant. Some leaves show distinct light and dark green stripes.
3. Slow, stunted growth.
4. In beans, slow stunted growth; general yellowing of the upper foliage with a browning or bronzing of the older or lower leaves.

Iron (Fe) deficiency symptoms are:

1. Greatest in effect on younger or bud leaves.
2. Pale to bright yellow color of entire plant, particularly noticeable on new leaves. Leaf margins may "fire."
3. Possible striping lower leaves of corn if deficiency is mild.
4. Leaf veins remaining green.
5. Short and slender stalks.

Copper (Cu) deficiency symptoms are:

1. In corn, the entire plant paling and youngest leaves turning yellow.
2. Dieback in younger parts of plants, which are first to be affected.
3. Alfalfa plants fading and taking on a grayish cast. There is sharply reduced growth; plants take on bushy appearance.

Manganese (Mn) deficiency symptoms are:

1. Greatest in effect on younger or bud leaves.
2. Spots of dead tissue on leaves.
3. Veins remaining green; tissue between veins chlorotic, similar to iron deficiency, but the green veins are wider.
4. In small grains, grayish areas appearing near the base of small plants.

Molybdenum (Mo) deficiency symptoms are:

1. In oats, bluish coloration of outer seed covering (glumes).
2. In legumes, older leaves pale greenish-yellow to yellow.
3. Plants dwarfed.

Chlorine (Cl) deficiency symptoms are:

1. Not recognized.

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INFORMATION SHEET #5

Improper Soil pH and Problems Associated with Improper pH

In highly alkaline soils, most soil organisms do not thrive well. Plants may also suffer from iron chlorosis, a condition identified by yellow-green leaves with dark green veins. Iron may be trapped in the soil and be thus unavailable to the plant.

In extremely acid soils, iron and aluminum may become toxic to some plants. Growth of fungi may increase at the expense of soil bacteria, bringing their ability to decompose organic matter to a complete halt.

INFORMATION SHEET #6

Soil Testing Services in Illinois

In response to inquiries about the location of soil testing services in different parts of Illinois, an information sheet listing soil testing laboratories is included in this problem area. These laboratories submitted soil samples for check testing to the Department of Agronomy, University of Illinois during the past year.

Reliable soil tests provide a valuable service to the people of Illinois. The soil testing program in Illinois is a decentralized service provided by local laboratories. The program is not rigidly regulated by any agency, but acquired direction from the Department of Agronomy and the Cooperative Extension Service of the University of Illinois and the Agricultural Stabilization and Conservation Service. These agencies are interested in helping to assure accurate soil tests, valid interpretation of these tests, and practical recommendations for soil treatments to Illinois farmers.

All agencies interested in the soil testing program agree that all soil testing laboratories in Illinois should meet the following minimum standards.

1. The standard of taking and testing 11 soil samples per 40 acres has been established. Although it may not be practical to adhere rigidly to this standard, one sample for every three to four acres should be used as a guide, depending on the soil type variations in any field.
2. A recommended soil treatment should be based on both an interpretation of the soil test results and a knowledge of the field history (cropping and treatment). Laboratories should either refuse samples that are not accompanied by a field history form or should return the results of the soil tests with the notation "Insufficient information for a sound interpretation."
3. The testing techniques provided by the University of Illinois Department of Agronomy must be used in making the tests, and the work must be done by a qualified soil testing technician.
4. The soil test report should clearly identify the laboratory and should accurately record the results of the soil tests.
5. To maintain an acceptable level of accuracy in the tests, each local laboratory must submit samples to the Agronomy Soil Testing Laboratory for check testing.
6. Recommendations for corrective soil treatment must be made by or under the direct supervision of a qualified person. An agriculture college graduate will be considered qualified if his or her training included work in soils and if he or she has kept abreast of developments in soil technology.

Soil Testing Laboratories — Alphabetical Listing

1. Adams County Farm Bureau
Soil Testing Laboratory
303 S. 36th St.
Quincy, IL 62301
Adams County

2. Agra Soil Service
312 Chestnut St.
Lena, IL 61048
Stephenson County

3. Alvey Laboratory
1511 E. Main
Belleville, IL 62222
St. Clair County

4. A.S.M. Service
Don Van Engelenburg
2403 Lyndhurst
Champaign, IL 61820
Champaign County

5. Brandt's Fertilizer Service Co.
P.O. Box 277
Pleasant Plains, IL 62677
Sangamon County

6. Bruch Laboratory
Cyndy Bruch
Box 339, R.R. #1
Granville, IL 61326
Putnam County

7. Gary Carter Trucking
Catlin, IL 61817
Vermilion County

8. Cepheus Industries
Box 525
Marion, IL 62958
Williamson County

9. Christian County Farmers Supply
Soil Testing Laboratory
P.O. Box 317
Stonington, IL 62567
Christian County

10. Coles County Soil Service
Lyle Wetael
R.R. #1, Box 24
Gays, IL 61928
Coles County

11. DeKalb County Farm Bureau
315 N. 6th St.
DeKalb, IL 60015
DeKalb County

12. Eastern Illinois Soil Testing
114 S. Chicago
Rossville, IL 60963
Vermilion County

13. Edwards County Farm Bureau
Soil Testing Laboratory
15 S. Fifth St.
Albion, IL 62806
Edwards County

14. Edwards Farm Supply
Box 9
Cisco, IL 61830
Piatt County

15. Edwards Soil Service
601 N. Court St.
Pontiac, IL 61764
Livingston County

16. Effingham Equity
Soil Testing Laboratory
P.O. Box 488
Effingham, IL 62401
Effingham County

17. Farmers Laboratory
1202 S. High Ave.
Freeport, IL 61032
Stephenson County

18. Farmers Soil Lab
R.R. #1
Wyanet, IL 61279
Bureau County

19. Farm Testing Service
Rt. #1, Box 12
Mascoutah, IL 62258
St. Clair County

20. Fayette County Soil Test Lab
c/o Jan Wollerman
Rt. #2, Box 274
Ramsey, IL 62080
Fayette County

21. G.M.S. Laboratory
Rt. #1, Box 51
Cropsey, IL 61731
Livingston County

22. Graymont Co-op Association
P.O. Box 56
Graymont, IL 61743
Livingston County

23. Greene County Farm Bureau
Soil Testing Laboratory
319 W. Side of Square
Carrollton, IL 62016
Greene County

24. Grundy County Farm Bureau
Soil Testing Laboratory
116 E. Washington
Morris, IL 60450
Grundy County

25. Hamilton County Soil Testing
Courthouse
McLeansboro, IL 62859
Hamilton County

26. Max Hutchens Fertilizer
R.R. #2, Box 68A
Assumption, IL 62510
Christian County

27. Kaiser Chemical Company
Soil Testing Laboratory
Box E
Sullivan, IL 61951
Moultrie County

28. Kaskaskia Soils Laboratory
P.O. Box 497
Shelbyville, IL 62565
Shelby County

29. Key Agricultural Services, Inc.
114 Shady Lane
Macomb, IL 61455
McDonough County

30. LaSalle County Farm Bureau
Soil Testing Laboratory
Rt. 23 North & Dayton Road
Ottawa, IL 61350
LaSalle County

31. Macoupin County Farm
Bureau
Soil Testing Laboratory
220 N. Broad St.
Carlinville, IL 62626
Macoupin County

32. Midwest Soil Testing Service
Box 125, 103 S. Front
Danforth, IL 60930
Iroquouis County

33. Mississippi Valley Soil
Testing
964 Broadway
Hamilton, IL 62341
Hancock County

34. Mowers Precision Crop
Counseling Service
107 N. Franklin
Toulon, IL 61483
Stark County

35. North Shore Sanitary District
P.O. Box 750 Russell Road
Gurnee, IL 60031
Cook County

36. Pike County Farm Bureau
Soil Testing Laboratory
Hwy 36E
Pittsfield, IL 62363
Pike County

37. Professional Agricultural
Services
Division of County Real Estate
1400 State St.
Beardstown, IL 62618
Cass County

38. Richardson Soil Testing
Laboratory
P.O. Box 96
Patoka, IL 62875
Marion County

39. Rich-Law Service Co.
P.O. Box 403, S. Whittle Ave.
Olney, IL 62450
Richland County

40. Scottland Soil Service
Scottland, Rt. #2
Chrisman, IL 61924
Edgar County

41. Sharp's Soil Testing Service
Tyler Elevator
P.O. Box 337
Elwood, IL 60421
Will County

42. Shields Soil Service
R.R. #1
Dewey, IL 61840
Champaign County

43. Skiles Soil Service
Soil Testing Laboratory
P.O. Box 267
Astoria, IL 61501
Fulton County

44. Soil Lab, Inc.-Independent
Soil Testing Service
120-1/2 E. Sale St.
Tuscola, IL 61953
Douglas County

45. Southern Ill. Farm Foundation
Soil Testing Laboratory
P.O. Box 335
Vienna, IL 62995
Johnson County

46. Sparks Soil Testing Laboratory
122 S. McLean, Box 841
Lincoln, IL 62656
Logan County

47. Spoon River F.S. Inc.
Soil Testing Laboratory
Ellisville, IL 61431
Fulton County

48. S.S.T. Laboratory
Tom Stoddard
R.R. #1, Box 304
Monticello, IL 61856
Piatt County

49. Standard Laboratories
P.O. Box 128
Goodfield, IL 61742
Woodford County

50. Stringer's Soil Service
R.R. #2
Assumption, IL 62510
Christian County

51. Top Soil Testing Service
27 Ash St., P.O. Box 340
Frankfort, IL 60423
Will County

52. Twin County Service Co.
Soil Testing Laboratory
215 N. 12th St., P.O. Box 246
Murphysboro, IL 62966
Jackson County

53. Volk's Fertilizer Service
Star Route Box 47
Newton, IL 62448
Richland County

54. Warren County Farm Bureau
Soil Testing Laboratory
1000 N. Main St.
Monmouth, IL 61462
Warren County

55. White County Farm Bureau
Soil Testing Laboratory
304 E. Robinson
Carmi, IL 62821
White County

56. Whiteside County Farm Bureau
Soil Testing Laboratory
100 E. Knox
Morrison, IL 61270

57. Zeller Laboratory
1711 W. 1st St.
Dixon, IL 61021
Lee County

Out-Of-State Laboratories

58. Agrico-Chemical Co.
Soil Testing Laboratory
P.O. Drawer 639
Washington Court House, OH 43160

59. Agri. Labs, Inc.
204 E. Plymouth
Bremen, IN 46506

60. A & L Great Lakes Agricultural Laboratory
5011 Decatur Rd.
Fort Wayne, IN 46806

61. A & L Midwest Agricultural Laboratory
13611 B. St.
Omaho, NB 68144

62. Amax Coal Co.- Midwest Lab.
5325 Oak Grove Rd
Evansville, IN 47715

63. Brookside Research Laboratories
308 S. Main St.
New Knoxville, OH 45871

64. CLC Labs
1046 Crupper Ave
Columbus, OH 43229

65. Dalby Agricultural Services
P.O. Box 2214
West Lafayette, IN 47906

66. Farm Clinic
932 Robinson St.
P.O. Box 3011
West Lafayette, IN 47906

67. Harris Laboratories, Inc.
P.O. Box 80837
624 Peach St.
Lincoln, NB 68501

68. Int. Mineral & Chemicals Corp. Agronomic Services Lab
1331 South First St.
Terre Haute, IN 47808

69. Iowa Testing Laboratory
P.O. Box 2214
West Lafayette, IN 47906

70. NaChurs Soil Testing Lab
421 Leader St.
Marion, OH 43302

71. Perry Agricultural Lab
R.R. #2, Box 219B
Bowling Green, MO 53334

72. Sohigro Soil Test Laboratory
P.O. Box 628
Lima, OH 45805

73. United States Testing Co.
Soil Testing Laboratory
3765 Premier Cove
Memphis, TN 38118

74. U.S.S. Agri-Chemical
204 W. Main St. Box 99
Belmond, IA 50421

75. WDHIC Soil & Forage Center
106 N. Cecil St.
Bonduel, WI 54107

INFORMATION SHEET #7

Soil Test Form A

DIRECTIONS FOR COLLECTING SOIL SAMPLES

FIELD SAMPLING

Start for the field to collect soil samples only after you understand the importance of sampling and how to do it. Over a period of years, a farmer is likely to invest several thousand dollars on the basis of results obtained from soil tests in a 40-acre field. It is easily possible to make hundreds of dollars for an extra hour spent in careful sampling and recording the location of each sample. The best laboratory tests in the world made on samples that are carelessly taken are not only worthless but may lead you to spend thousands of dollars for plant nutrients that you don't need while you neglect to buy nutrients that your fields lack.

When the soil finally gets into the test tube in the laboratory, about *1 teaspoonful is going to represent 2 to 5 acres. It had better be the right teaspoonful!*

The leaflet is planned to help you to understand how to get samples that will provide a sound basis for investing your money in fertilizer and limestone. Take time to study it.

MATERIALS YOU WILL NEED

A supply of at least 11 small paper sacks (for a 40-acre field).

A basket or box for carrying the samples.

A pan or bucket for mixing the small samples.

A trowel, spade, or auger to dig the samples.

STEP NUMBER 1. PLAN WHERE TO SAMPLE AND HOW MANY SAMPLES TO TAKE.

First check the descriptions under situations A and B to decide which plan to follow.

Situation A. Fields that appear to have only one kind of soil and where recent past cropping and fertilizer and limestone treatments have been the same throughout. You may follow a regular pattern as indicated on the diagrams on the back of this sheet.

For a 10-acre field take 4 samples at locations corresponding to 1, 2, 6, and 7 on the diagram for a 20-acre field.

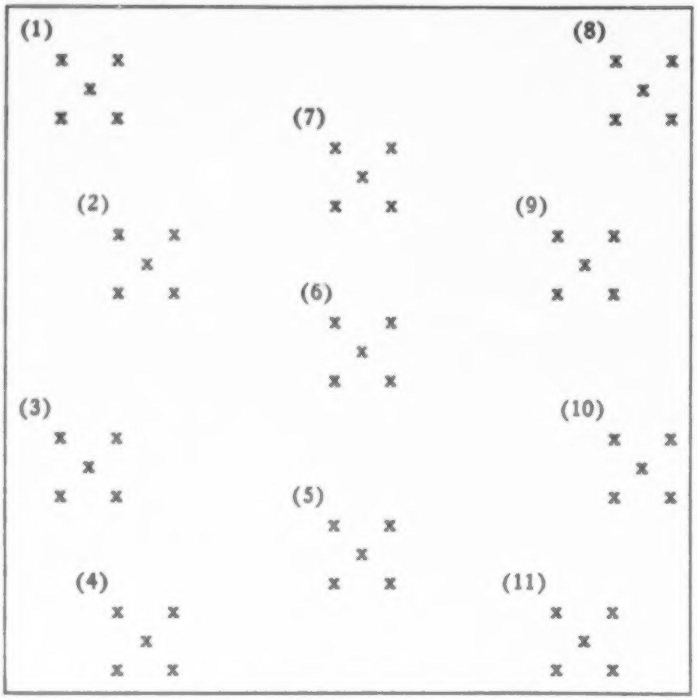
Each sample shown by a number on the diagram is a mixture of 5 small samples taken within a square rod at the places shown by the x marks. The reason for taking these 5 small samples is to make certain that the whole sample does not come from within a band of fertilizer applied in a previous year.

Eleven samples are suggested for a 40-acre field, 7 for 20 acres, and 4 for 10 acres in order to outline areas with different fertility status due to unseen soil differences or differences in previous fertilizer or limestone applications or cropping systems.

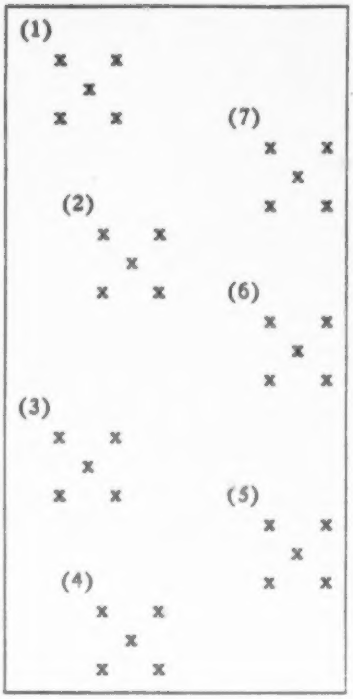
Situation B. Fields that have different kinds of soil, that have problem areas, or that have been cropped, fertilized, or limed differently in the past 5 to 10 years.

The same general suggestions apply as outlined under situation A, but you will want to take enough additional samples to fully represent the different conditions within the field. This is a matter of judgment, but remember that a few extra samples take little time or money but may give a much better picture of the fertility status of the field. Fields are sampled only once in 4 to 8 years. Don't gamble on short cuts to a good sampling job.

40-acre field



20-acre field



STEP NUMBER 2. TAKE THE SAMPLES AND RECORD THE LOCATION OF EACH SAMPLE AND OUTLINE LOW SPOTS, KNOLLS, DRAWS, ETC., ON THE MAP.

This information is needed to help you or the person who interprets the tests arrive at the proper treatment. If you plan to treat according to soil tests, *then you must know where each sample came from!*

STEP NUMBER 3. PREPARE THE SAMPLES FOR TESTING.

Let the samples air-dry with the tops of the containers open for several days. Don't rush the drying process by placing samples on a stove or radiator. This will produce misleading test results.

Break up clods and lumps so the soil will pass through ordinary window screen. The samples are ready for testing.

STEP NUMBER 4. FILL OUT THE INFORMATION SHEET, SOIL TEST FORM B.

This form lists the cropping history, previous fertilizer, lime, and manure treatments, and other information to supplement the information supplied by the soil tests and thus lead to more sound fertility suggestions. *The soil test is an important tool in diagnosing fertility needs and in suggesting treatments, but it should never be the only tool.* Here is an illustration to prove the point. If you apply limestone according to the results of a soil test and then retest within two years, the second test will show a considerable limestone requirement even though there is enough in the soil for high yields of legumes. The soil test by itself in this case is misleading.

STEP NUMBER 5. MAIL OR TAKE THE SAMPLES TO THE LABORATORY.

INFORMATION SHEET #8

Soil Test Form B

SOIL SAMPLE INFORMATION SHEET

(To accompany soil samples; complete one form for each field)

DATE ____________

______________ ______________ County

Township ____________
Section ________ Qtr. ________
Field ____________
Acres ____________
Samples ____________

Tests Desired:
pH ____________
P-1 ____________
K ____________
OM ____________

TENANT ______________________ ADDRESS ______________________

OWNER ______________________ ADDRESS ______________________

In order that the results of the test may be properly analyzed and interpreted, the following information should be submitted with the samples from each field:

1. Soil type name ______________________.
2. Kind of soil: sandy ________ silt loam ________ clay ________ muck ________.
3. Is drainage good ________ fair ________ poor ________?
4. Has the field been limed recently? ________ When? ________ Amount per acre ________.
5. Amount of fertilizer applied per acre last year: N ________ P_2O_5 ________ K_2O ________.
6. Cropping intentions for next four years, expected yields, and tillage system (plow, chisel, disk, no-till, etc.):

	Intended crop	Expected yield	Tillage system
This year	________	________	________
Next year	________	________	________
Third year	________	________	________
Fourth year	________	________	________

7. How deep do you plow? ______________________.
8. Are there any special problems? ______________________

____

____

____

____

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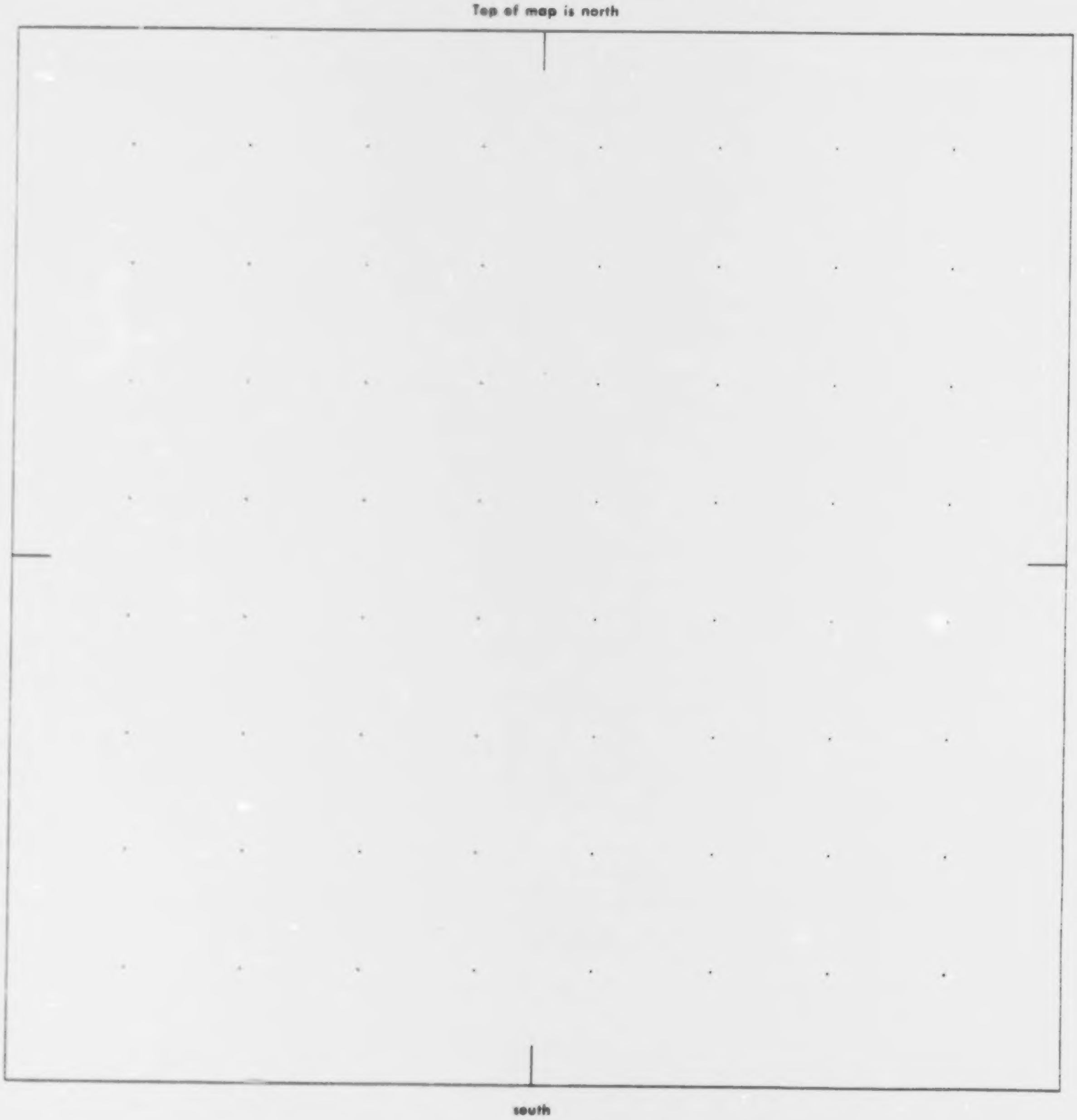
INFORMATION SHEET #9

MAP OF THIS FIELD

(Number the sample locations)


Top of map is north
south

INFORMATION SHEET #10

Soil Test Form B

SOIL SAMPLE INFORMATION SHEET

(To accompany soil samples; complete one form for each field)

DATE

Brown County

Township Land
Section 12 Qtr. NE
Field I
Acres 66
Samples 22

Tests Desired:
pH X
P-1 X
K X
OM X

TENANT Jack Farming ADDRESS Route 3, Goodland, IL 00101

OWNER Milo Sorghum ADDRESS Fieldcrop, IL 00000

In order that the results of the test may be properly analyzed and interpreted, the following information should be submitted with the samples from each field:

1. Soil type name Drummer, Raub, Parr, Dana .
2. Kind of soil: sandy ____ silt loam X clay ____ muck ____.
3. Is drainage good Parr Dana fair Raub poor Drummer ?
4. Has the field been limed recently? Yes When? 5 yrs ago Amount per acre 3.3 Ton/Ac North 46 2.0 Ton/Ac South 20
5. Amount of fertilizer applied per acre last year: N None P_2O_5 100 lbs/Ac East 30 200 lbs/Ac West 36 K_2O 150 lbs/Ac [illegible] 30 200 lbs/Ac West 36
6. Cropping intentions for next four years, expected yields, and tillage system (plow, chisel, disk, no-till, etc.):

	Intended crop	Expected yield	Tillage system
This year	Corn	200 bu/Ac	Plow after corn
Next year	Soybeans	60 bu/Ac	No fall tillage after beans
Third year	Corn	200 bu/Ac	
Fourth year	Soybeans	60 bu/Ac	

7. How deep do you plow? 7" -- 9" .
8. Are there any special problems? The Drummer soil tends to pond in some areas. There is a 10 percent slope in the Northwest section of the field. The area around Site #10 is where the sold barnyard was located.

One sample was raken for every 3 acres of land. Each sample is a composite of 5 cores taken 6"-7" deep from an area about 15 feet square. Note Field map to locate sampling sites and the soil types in the field.

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INFORMATION SHEET #11

Suggested Instructions for Obtaining Soil Samples from Lawns, Gardens, and Ground Beds

1. Obtain at least one composite sample for each soil difference. Differences can be due to texture, slope, color, drainage, or past treatment. If a "problem area" is sampled, keep it separate from the other composite samples.

2. For a composite sample obtain 10-15 samples from each area. Samples from individual beds should not be mixed. Take samples to a depth of 6 inches in flowerbeds and gardens and 4 inches in lawns.

3. Mix the soil for the composite sample and take out about one pint. Label each composite sample with a number and name. Keep a record of the area from which the samples came and fill out the information sheet "B" as completely as possible. Also include the following:

   a. The size of area (dimensions or number of square feet): ____________________

   b. How many years has garden (or lawn or flowers) been in this spot? ____________

   c. Do you have manures, compost, leaves, or other organic material available each year? (Yes or No) ______
   If so, how much? ____________

   d. What particular difficulties do you have with plant growth in this area? ____________
   ____

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INFORMATION SHEET #12

Suggested Procedures for Sampling Greenhouse Soils

A. Stockpiles of Soil Mixes

1. Take 10-15 samples from various locations in the stockpile and mix to obtain one composite sample.
2. Do not sample the surface. (Salt content may be higher due to evaporation.)
3. Sample to a depth of 10-12 inches.

B. Potted Crops

1. Use 10-15 pots to make a cross section of a composite sample.
2. In large pots a probe can be used with minimum damage to the root system. In small pots the root ball will need to be removed from the pots and sample of soil removed from the top of the bottom to the root ball where the roots are actively growing. The soil can be replaced by soil stock mix.

INFORMATION SHEET #13

Soil Test Form **D-2**

LIME — MAP AND INTERPRETATION

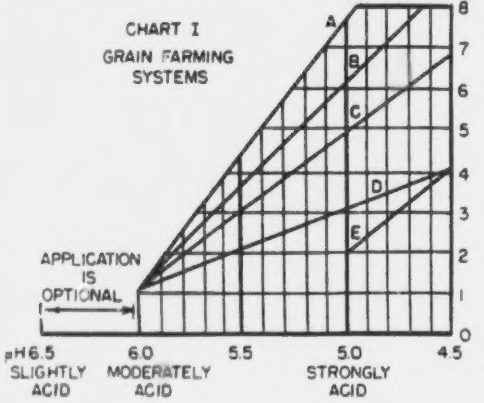
The field map below shows the pH for each sample. Figures on the charts for limestone needed are based on these assumptions:

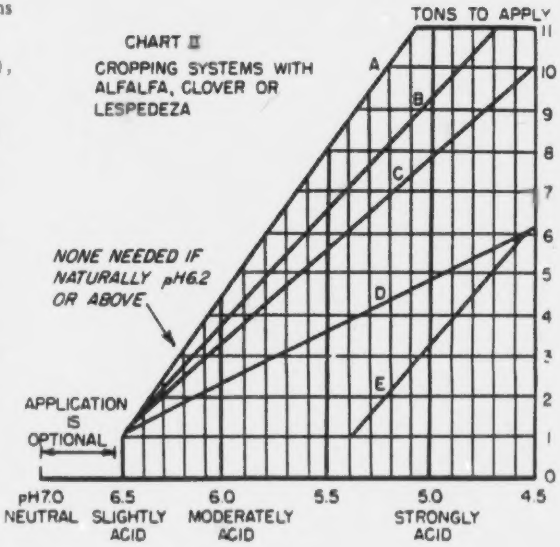
1. A 9-inch depth of plowing. For each inch less, the limestone requirement may be reduced by 10 percent.
2. Typical-fineness limestone — 90 percent through 8-mesh, 60 percent through 30-mesh, 30 percent through 60-mesh.
3. A calcium carbonate equivalent (total neutralizing power) of 90 percent. (See back of sheet for explanation.)

If these assumptions do not apply to your situation, adjust the limestone rate accordingly.

STEPS TO FOLLOW

1. Use Chart I for grain systems and Chart II for alfalfa, clover, or lespedeza.
2. Decide which soil class fits your soil —
   - A. Silty clays and silty clay loams (dark).
   - B. Silty clays and silty clay loams (light and medium). Silt and clay loams (dark).
   - C. Silt and clay loams (light and medium), sandy loams (dark), loams (dark and medium).
   - D. Loams (light), sandy loams (light and medium), sands.
   - E. Muck and peat.
3. Find your soil's pH along the bottom of the chart.
4. Follow up the vertical line until it intersects the diagonal line A, B, C, D, or E that fits your soil.
5. Read the suggested rate of application along the right side of the chart that you are using.





SOIL-ACIDITY MAP

REMARKS

If the amount of limestone is 6 tons or more and initial cost is a factor, apply 2/3 the first time and the rest 2 to 4 years later

For more information on liming, see the back of this sheet and also Circular 721 (mimeographed).

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INFORMATION TO HELP YOU PLAN A LIMING PROGRAM

Reasons for Liming

Liming acid soils improves most crops because:

1. It reduces the solubility of manganese and aluminum that are present in strongly acid soils in amounts large enough to be toxic, especially to alfalfa and clover.
2. It improves the soil for microorganisms that speed the decay of plant residues, thus releasing more nitrogen and phosphorus for crop plants.
3. It favors the growth of nodule-forming bacteria (those that take nitrogen from the air) on alfalfa, clover, and soybeans.
4. The best balance in availability of minor elements is found in soils that are neutral or only slightly acid.
5. Phosphorus is more available in soils that are near neutral in acidity than it is in strongly acid soils.

Suggested pH Goals

For cropping systems with **alfalfa** and **clover**, maintain a pH of 6.5 or above. But if the soils have a pH of 6.2 or above without ever having been limed, neutral soil is just below plowing depth and it will probably not be necessary to apply limestone.

For **cash-grain** systems (no alfalfa or clover), maintain a pH of at least 6.0. If the soil test shows that the pH is 6.0, apply limestone to prevent a drop below 6.0. Farmers may choose to raise the pH to still higher levels. After the initial investment, it costs little more to maintain a pH of 6.5 than one of 6.0. The profit over a 10-year period will be affected very little since the increased yield will about offset the original cost of the extra limestone (2 or 3 tons per acre) plus interest. Raising the pH above 6.5 in cash-grain systems unnecessarily increases the risk of nitrogen loss through denitrification.

The amounts of **soil organic matter** that correspond to the color terms used in describing soil classes (excluding sands) on the other side of the sheet are: light — less than 2½ percent; medium — 2½ to 4½ percent; dark — more than 4½ percent.

Liming Materials

Nearly all of the liming material used in Illinois is agricultural ground limestone, commonly called agstone or lime. It may be calcitic (nearly all calcium carbonate) or dolomitic (containing magnesium). The maximum magnesium carbonate content is about 45 percent. There is no area in Illinois where one type is preferred over the other.

The two main characteristics that determine the value of lime are its neutralizing power and its fineness.

The **neutralizing power** (calcium carbonate equivalent) of limestone is its power to neutralize soil acids as compared with the neutralizing power of pure calcium carbonate. The neutralizing power of limestone sold in Illinois ranges from about 65 to 109. The higher the neutralizing power, the more valuable the limestone. Limestone that is in the lower range may be just as good a bargain as that in the higher range *if it is priced in line with the difference in neutralizing power.*

The **fineness**, or size, of limestone particles largely determines the rate at which they react with soil acids. The practical problem is how to compare limestones that differ in fineness and price. Your extension adviser and ASC office have the screen scores showing the fineness of limestone for sale in your area.

If you are liming a strongly acid soil shortly before seeding alfalfa or clover, the values for 1 year in the table at right are the best guide. If lime is applied on sod before plowing for corn, the 4-year values are the best to use. If the fields have been limed in the past and a long-term maintenance application is to be made, the 8-year figures are satisfactory.

Comparative Values of Limestone of Varying Particle Sizes Evaluated 1, 4, and 8 Years After Application

Size fraction	Years after application		
	1	4	8
Through 60 mesh	100	100	100
30 to 60 mesh	50	100	100
8 to 30 mesh	20	45	75
Over 8 mesh	5	15	25

When to Lime

Fortunately limestone may be applied at many points in the crop rotation. It is best to lime soils for the first time 6 months to a year ahead of the alfalfa or clover seeding, but in emergencies limestone that contains a high proportion of 60-mesh material can be disked in (not plowed under) just ahead of seeding.

Retesting Limed Fields

Soil tests within 2 years after liming are unreliable. Where lime has been applied according to soil tests, alfalfa, clover, and other crops will grow well even though the soil still tests more acid than is desired. There is little reason to retest a well-limed field more often than about every 4 years. Eight to 10 years is often enough to retest fields with a naturally high pH.

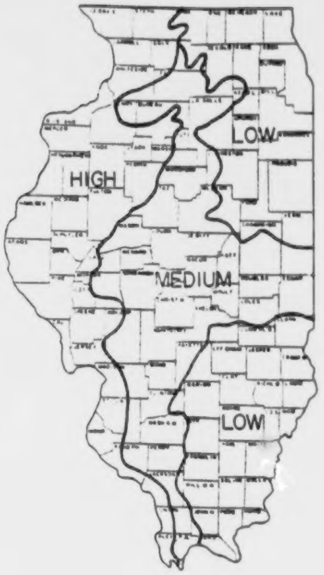
Where high rates of nitrogen (150 pounds or more per year) are applied, retesting is suggested every 4 years because nitrogen fertilizer increases soil acidity.

Issued in furtherance of Cooperative Extension Work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. JOHN B CLAAR, *Director*, Cooperative Extension Service, University of Illinois at Urbana-Champaign.

Soil Test Form **D-3**

PHOSPHORUS — MAPS AND INTERPRETATION

PHOSPHORUS-SUPPLYING POWER



FIELD MAP OF P_1 TEST

The soil test will probably increase about 1 pound for every 9 pounds of P_2O_5 fertilizer (4 pounds P) applied. Rates of 120 and 150 pounds are for those who desire a rapid buildup in available phosphorus.

The highest drill rates are considered to be all that can be profitably placed in the band but they will have little effect on the soil test in following years and hence do not substitute for larger amounts broadcast for rapid buildup.

STEPS TO FOLLOW

1. Illinois has tentatively been divided into four regions in terms of inherent phosphorus-supplying power of the soil below plow layer in dominant soil types. These regions are shown on the map of Illinois at left. *Decide into which group your soil falls* with respect to phosphorus-supplying power.

2. Consulting the table at right and the present phosphorus levels on your field as shown on the field map on this sheet, *study the paragraph checked below.*

Suggested Long-Term Goals for P_1 Test Levels

Phosphorus-supplying power	Where row fertilizer is applied for corn	Where no row fertilizer is applied for corn
Low	40–50	50–60
Medium	35–45	40–50
High	30–40	35–45

☐ Phosphorus is below the most profitable level. Phosphorus applications should, therefore, be large enough to not only meet the needs of the next crop but also to raise the soil test level.

☐ Phosphorus is at the suggested level. You may broadcast phosphorus this year and, thereafter, 50 pounds of P_2O_5 annually (or 100 pounds to last 2 years or 150 pounds to last 3 years) to at least maintain the test level until the field is sampled again.

☐ Phosphorus is well above the level believed to be needed. Therefore no yield increase is likely from an application of phosphorus this year.

☐ Phosphorus is so high that you run the risk of creating problems with other nutrients.

3. *Choose between rock phosphate and more available phosphates.* (See back of sheet.)

4. Consulting the table below, *decide where and how to apply the needed phosphorus for maintenance applications on alfalfa and clover.*

P_1 test Soil region (see map)			Percent possible yield	Pounds of P_2O_5 to be added per acre based on the P_1 test Broadcast		Through planter or drill
low	*med.*	*high*		**for corn or soybeans**		
20	10	7	69	or (a) 90 to 150	plus	20 to 40
25	15	10	83	(b)		40 to 60
30	20	15	90	60 to 120	or	30 to 40
38	30	20	97	60	or	20 to 30
45	40	30	98+	Phosphorus may be applied to maintain the soil test. Little or no response likely in the year of application.		
all regions				**for wheat and oats**		
10 to 15			Below 47	90 to 150	plus or	30 90
20			57	60 to 120	plus or	30 80
30			72	60 to 90	or	60
40			82	60	or	30 to 60
60			92			30

for alfalfa and alfalfa-grass mixtures before seeding when seeded alone

low	*med.*	*high*	*broadcast seeding* *expected yield per acre (tons)* 2-3	3-5	*band seeding* *expected yield per acre (tons)* 2-3	3-5
25	15	10	120	180	60	90
30	20	15	90	150	50	80
38	30	20	60	90	30	60
45	40	30	60	60	30	40
60	50	40			20	30

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INFORMATION TO HELP YOU PLAN A PHOSPHORUS PROGRAM

What Determines the Phosphorus-Supplying Power?

High phosphorus-supplying power means:

1. The amount of available phosphorus (P_1 test) in the subsoil is relatively high.
2. The conditions are favorable for good root penetration and branching in the subsoil.

Low phosphorus-supplying power may be caused by one or more of the following factors:

1. A low supply of available phosphorus in the subsoil because (a) the parent material was low in phosphorus; (b) phosphorus was lost in the soil-forming process; or (c) the phosphorus is made unavailable by high pH (calcareous) material.
2. Poor internal drainage that restricts root growth.
3. A dense, compact layer that inhibits root penetration or spreading.
4. Shallowness to bedrock, sand, or gravel.
5. Drouthiness, strong acidity, or other conditions that restrict crop growth and reduce rooting depth.

Suggested Annual Maintenance for Alfalfa, Grasses, and Alfalfa-Grass Mixtures

Phosphorus-supplying power rating of soil	Yield expected or obtained (tons dry matter per acre) 5	7	10
	Pounds P_2O_5 per acre		
Low	55	77	110
Low to medium	44	62	88
Medium	38	54	77
Medium to high	33	46	66
High to medium	28	38	55

Annual vs. Infrequent Applications

Applying phosphorus every 2 or 3 years (up to 4 years for alfalfa) is as effective as applying smaller amounts each year and it saves labor. Mixing the fertilizer into the soil by plowing, disking, or chiseling will reduce the likelihood of it being carried off the field through erosion. This may reduce excessive algae growth in lakes and reservoirs but it is probably not important in Illinois streams.

Illinois Tests for Phosphorus

Illinois laboratories make two tests for phosphorus, referred to as P_1 and P_2. The P_1 test (interpreted on the front of this sheet) measures readily available phosphorus. The P_2 test uses a stronger extractant and therefore measures both available phosphorus and phosphorus that has been built up with rock phosphate but has not yet been converted to available form. The P_1 test is a better indication of the soil phosphorus supply for this year's crop and also for the next year or two.

The P_2 test is used as a guide to the application of rock phosphate (see table at right). The results of this test are necessary for ACP practice payments.

If the P_2 test has been built to 50 or above through applications of soluble phosphates, the rating of the P_2 test in the table is too low and the suggested application is too high. A P_1 test is needed to show the status of available phosphorus.

Suggested Application of Rock Phosphate Based on the P_2 Soil Test

P_2 test	Rock phosphate for 8 to 10 years
	lb. per acre
Below 20	1,500
20 to 32	1,300
33 to 53	1,000
54 to 75	800
Above 75	No build-up application, but soluble phosphate is needed for wheat

Rock Phosphate or More Available Phosphate?

Rock phosphate contains about 30 perrent total P_2O_5 of which about 1/10 is as available as that in other phosphorus-supplying fertilizers. The most economic use of rock phosphate is related to soil pH and to the amount of alfalfa or clover in the cropping system. **At pH 6.5 or above,** rock phosphate is not likely to be as economical as other sources. **At pH 6.0 to 6.5,** rock phosphate and more readily available forms may be equally profitable if (a) alfalfa, clover, lespedeza, or birdsfoot trefoil is an important part of the cropping system; (b) the soil is inherently moderately acid; and (c) ACP cost-sharing assistance is available. **Below pH 6.0,** there is enough soil acidity to efficiently release phosphorus from phosphate rock, so rock may be used in a soil-buildup program.

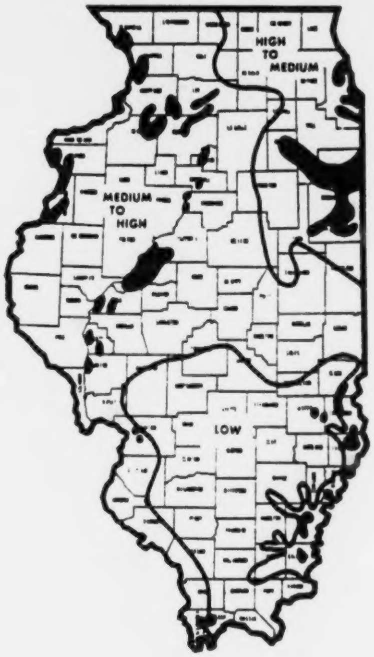
To Convert P_2O_5 Figures to Amount of P Contained

Phosphorus fertilizers are added in order to supply phosphorus. However, it has long been the custom to show percentages in terms of P_2O_5 content. To find the amount of P in P_2O_5, multiply the P_2O_5 figure by 0.44.

Soil Test Form D-4

POTASSIUM (K) — MAPS AND INTERPRETATION

POTASSIUM-SUPPLYING POWER



STEPS TO FOLLOW

1. ***Decide into which group your soil falls*** with respect to potassium-supplying power. Illinois is divided into four general regions in terms of inherent potassium-supplying power. These regions are shown on the map of Illinois at left. There are, of course, important differences among the soils within these general regions because of the seven factors listed on the back of this sheet. Soils in the areas of the map shown in solid black are sands.

2. ***Study the paragraph checked below*** together with the field map of K tests which shows the present potassium levels on your test field.

☐ Potassium is below the most profitable level. Potassium applications should, therefore, be large enough to not only meet the needs of the next crop but also to raise the soil test level.

☐ Potassium is at the suggested level. You may broadcast potassium annually or at 2- to 3-year intervals to at least maintain the test level until the field is sampled again.

☐ Potassium is well above the level believed to be needed. Therefore no yield increase is likely from an application of potassium this year.

☐ Potassium is so high that you run the risk of creating problems with other nutrients, especially magnesium.

3. ***Decide where and how to apply the needed potassium*** by consulting the table below. The table is based on tests of samples taken between May 1 and September 30. Samples should never be taken when the soil is frozen. Seasonal adjustments for samples taken before April 30 and after October 1 are as follows: Dark-colored soils — subtract 30; light-colored soils in central and northern Illinois — subtract 45; low potassium-supplying soils south of Illinois Route 16 — subtract 60; fine-textured bottomland soils — subtract 45.

FIELD MAP OF K TEST

Soil test range	Estimated percent of maximum possible yield		Potassium rates to build soil test and to last 2 years (See back of sheet for 3rd and 4th years)			
	Corn, soybeans, alfalfa, clover	Wheat, oats	Soils LOW in potassium-supplying power		Soils MEDIUM to HIGH in potassium-supplying power	
			K_2O	K	K_2O	K
			lb.	*lb.*	*lb.*	*lb.*
90 or less	75 or less	90 or less	300	250	These soils are seldom this low	
91 to 120	76 to 81	91 to 94	270	225		
121 to 150	82 to 90	95 to 97	240	200	210	175
151 to 180	91 to 93	98 or more	210	175	180	150
181 to 210	94 to 95	98 or more	180	150	150	125
211 to 240	96 to 97	98 or more	150	125	120	100
241 to 300	98 or more	98 or more	120	100	See "When to Apply" on back of sheet	

Alfalfa or Alfalfa-Grass Seeding Without a Companion Crop (See Back of Sheet for Maintenance Rates)

K test level	Expected yield: seeding year if spring sown; following year if fall sown	
	2 to 3 tons	3 to 5 tons
	Pounds of K_2O to apply per acre	
90 or less	160	220
91 to 120	120	180
121 to 150	80	140
151 to 180	0	100
180 and above	0	0

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Suggested Annual Potassium Maintenance Fertilization for Alfalfa, Grasses, and Alfalfa-Grass Mixtures After Soil Tests Are Built to High Levels

Nutrient-supplying power rating of soil (see map on front)	Percent of nutrients to be supplied by fertilization	Yield expected or obtained (tons dry matter per acre)		
		5	7	10
		Pounds K_2O per acre		
Low	100	250	350*	500*
Low to medium	80	225	315*	450*
Medium	70	200	280	400*
Medium to high	60	175	245	350*
High to medium	50	150	210	300
High	50	125	175	250

*Rates above 300 pounds K_2O should be split and applied at two different dates to prevent plant injury.

INFORMATION TO HELP YOU PLAN A POTASSIUM (K) PROGRAM

Why Soils Differ in Natural Supply of Potassium

Inherent potassium-supplying power depends mainly on:

1. The amount of clay and organic matter. This influences the exchange capacity of the soil.
2. The degree of weathering of the soil material. This affects the amount of potassium that has been leached out.
3. The kind of clay mineral.
4. Drainage and aeration. These influence the uptake of potassium.
5. pH. Very high calcium and magnesium reduce potassium uptake.
6. The parent material from which the soil formed.
7. Compactness or other conditions that influence root growth.

A soil test goal of 241 to 300 is suggested for all the regions. Rates of potassium suggested in the buildup period and for maintenance on soils that are classified low or medium in potassium-supplying power are larger than those for soils that are classified high.

Recent results show that a few soils respond to potassium applications even at tests above the suggested goal of 241 to 300. Research to identify these soils is continuing. They are likely to be fine-textured, very dark, and imperfectly drained.

Sandy soils are low in potassium-supplying power because they are low in exchange capacity and cannot hold much reserve K. In addition, minerals from which sandy soils develop are low in K.

The silt loams in the "low" area in southern Illinois (claypans) are relatively older soils in terms of soil development and consequently much more of the potassium has been leached out of the root zone. Furthermore, wetness and a platy structure in the upper subsoil may interfere with rooting and with K uptake early in the growing period even though roots are present.

Soils in northeastern Illinois that were formed from medium- to fine-textured till are quite high in potassium by soil test, but restricted drainage may reduce potassium uptake during the early part of the growing season. As a result, those soils with wetness problems have only a medium rating in their ability to supply potassium to crops.

When to Apply Potassium in the Cropping System

Corn, soybeans, and forage legumes are most sensitive to a potassium shortage. Applications should be timed to meet their needs.

On soils that have a very low potassium test, you may apply the suggested initial applications (even up to 300 pounds of K_2O per acre) at one time or you may apply 2/3 the first year and 1/3 the second year. For the third and fourth years, or until the field is resampled, the following approximate maintenance amounts are suggested: 60 pounds of K_2O per year or 120 pounds to last 2 years; double the amount on fields where silage or hay is removed and no manure returned.

There is no hard-and-fast rule for dividing the potassium over a 4-year cropping period. Broadcast applications every second or third year are as effective as smaller annual applications.

Safe Limits for Drill Applications

Since potassium salts are very soluble, large amounts cannot safely be placed near the seed. Nitrogen and potassium combined should not exceed about 40 pounds per acre for corn in 40-inch rows through a split boot. Larger amounts are safe through a planter with side placement of the fertilizer away from the seed. No more than 12 pounds should be applied as a pop-up fertilizer in contact with the seed.

Up to 40 pounds of K_2O (33 pounds of K) plus nitrogen is safe through the drill for small grain.

Soybeans are very sensitive to salt injury and no more than 40 pounds of K_2O (33 pounds of K) is suggested for side placement. Broadcast application of all potassium is preferred for soybean. Pop-up placement is discouraged.

INFORMATION SHEET #14

Soil Sample Test Results

Additional Information for Teachers

Recommendations: All fertilizer recommendations are based on information in the current edition of the Agronomy Handbook. As to the exact rates and zones of fertilizer application, there is an element of subjective interpretation which is based on experience. The students should use their own experience to modify the recommendation to suit the individual operation.

Procedure: The students should be encouraged to develop a field map for each test, plotting the recommendations at each sample site. This will aid the students in visualizing the fertility recommendations for the field.

Example: The sample form is for class discussion and for an example as to how the forms would be completed and the results analyzed. When discussing the results the students should have a copy of the handout, "Soil Treatments Based on Soil Tests," and Illinois Soil Test Reports D-1, D-2, D-3, and D-4.

INFORMATION SHEET #15

Organic Fertilizers

I. Crop Residues

A. Methods used to return crop residue to the soil efficiently include:

1. Conservation tillage.
2. Mulch farming.
3. Minimum tillage.
4. No tillage.
5. Strip tillage.
6. Zero tillage.
7. Sweep tillage.
8. Plow-plant.
9. Wheel-track planting.

B. Advantages of crop residues include:

1. Less erosion by water and wind.
2. More infiltration of rain.
3. Greater water-holding capacity.
4. More water available to plants.
5. Lower soil temperature in summer but higher in winter.
6. More soil humus.
7. Less surface crusting.
8. Fewer tillage pans.
9. Lower tractor fuel costs.
10. Better soil tilth with less tilling.

C. Disadvantages of crop residues include:

1. Poor adaptation to northern latitudes; temperature too cold and soils too poorly drained.
2. Presence of more insects, diseases, weeds, and rodents.
3. Slower seed germination due to more wetness and coldness in the soil surface.
4. Slower seed germination also due to water-soluble toxins in residues from sweetclover, corn, wheat, oats, and sorghums.

II. Animal Manures

Ninety percent of all animal manures are used for soil improvement. In general, crop yields are higher with the use of manures as compared with the use of chemical fertilizers. A few reasons to explain the superiority of manures are:

A. The presence of secondary nutrients and micronutrients in manure.

B. Improvement in desirable tilth (soil physical condition) resulting from application of manure.

C. Release of nutrients by microbial decomposition of manures in harmony with the needs of growing plants.

III. Sewage Sludge

There are four reasons why most farmers ignore this resource as a fertilizer. These are:

A. A dislike for the odors of and the ideas associated with human effluent.

B. The cost, which in most instances is more expensive than for chemical fertilizers providing equivalent nutrients.

C. The possible spread of pathogens (disease-producing organisms). This would pose a very serious hazard to livestock and humans.

D. The content of heavy metals, especially cadmium, which would also pose a threat to livestock and humans.

IV. Septage

Septage is an anaerobic mixture of liquids and solids pumped from residential septic tanks. It consists of 95-97 percent water and 3-5 percent solids.

Septage should be stored in a lagoon for a month before being spread on soils near humans. This will allow most of the foul odors to disappear.

V. Compost

Organic materials suitable for making a compost include all animal manures, sewage sludge, tree leaves, grass clippings, garden weeds, hay, straw, sawdust, peat, garbage, cotton gin trash, rice hulls, and most other organic refuse.

Avoid grass clippings and hay with viable grass or weed seeds or viable sprigs of grasses such as bermudagrass or quackgrass, weeds that have gone to seed, garden refuse that is diseased, and tree leaves that resist decomposition.

Commonly build a retaining barrier with about a 2-inch mesh woven wire, about 4 feet high and any diameter, suitable to accommodate the volume of organic matter to be used.

Add organic material whenever it becomes available.

Always flatten top or depress the middle of pile to increase water penetration.

Chemical fertilizers should be sprinkled evenly over the surface at every 4-inch depth of compost. This will hasten decomposition.

VI. Municipal, food processing, and industrial organic Residues

Normally these wastes are dumped in the ocean, burned, or buried in a landfill. However, they work very nicely for composting and have much potential future use as soil amendments.

VII. Peat

Peat is a naturally occurring organic material that has accumulated over may centuries in wet, cool places. There are five main types:

A. Moss peat — originates mainly from sphagnum moss or hypnum moss; brown in color, high acidity, and very high water-holding capacity; used for soil conditioning, top-dressing lawns, surface mulching, rooting cuttings, acidifying soils, mixing with potting soil, and planting nursery stock.

B. Reed-sedge peat — originates from residues of reeds, sedges, marsh grasses, and cattails; brown to reddish brown in color; moderate water-holding capacity; used as soil conditioner and potting soil mix, and for top-dressing lawns.

C. Peat humus — originates from decomposed hypnum moss, peat, or reed-sedge peat; dark brown to black in color; used as soil conditioner and soil mix, and for top-dressing lawns.

D. Muck soil — originates from decomposed peat; dark gray to black; sold as "topsoil," "humus," or "peat," for top-dressing lawn areas before seeding or sodding.

E. Sedimentary peat — Originates from bottom of certain ponds from partially decomposed algae, plankton, water lilies, and pond weeds; dark gray to black; no positive value as a soil conditioner, a top-dressing, or a soil mix.

INFORMATION SHEET #16

Acid Rain

Acid rain is precipitation containing certain acids and acid-forming substances falling on soils, plants, and open waters.

Some people have charged that emissions of gaseous substances from power-generating plants and factories contain acids and acid-forming substances that are responsible for the acid nature of certain soils.

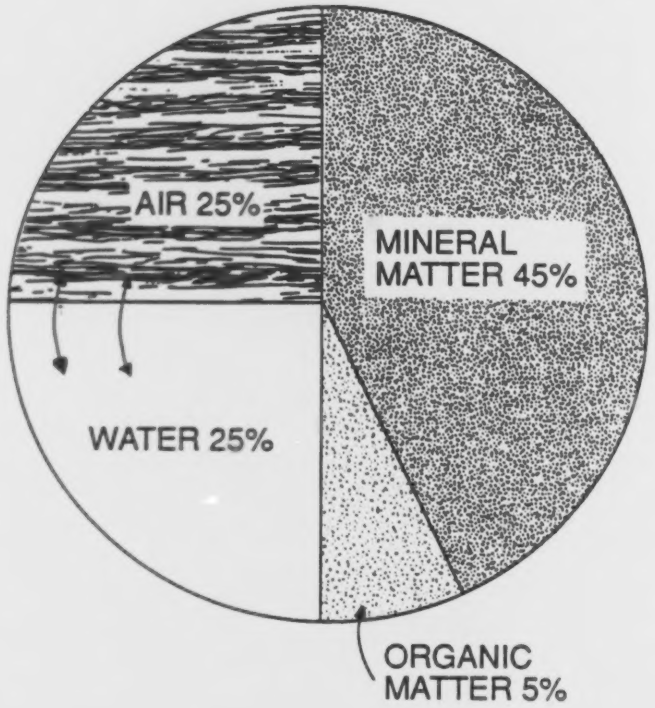
These modern sources of acid deposition from the atmosphere are not responsible for all acid soils in the world. Acid soils are predominant in all humid regions. They have been acid for a long time.

Acids reach soils of humid regions from several sources. Falling rain absorbs and reacts with oxides of carbon, nitrogen, and sulfur from the air to become slightly acid. The added nitrogen and sulfur are absorbed in part by plants during their growth. When plants and microorganisms die and the residue decays, the two elements are released to form nitric and sulfuric acid. Plants also produce some organic acids, released by roots in the soil. Finally, the decay of surface litter, plant roots, and humus produces organic acids.

Acidic soils tend to become more acidic, particularly where leguminous crops are grown and nitrogen fertilizers are used. Under these conditions, acid precipitation is only a minor source of acidity.

TRANSPARENCY MASTER #1

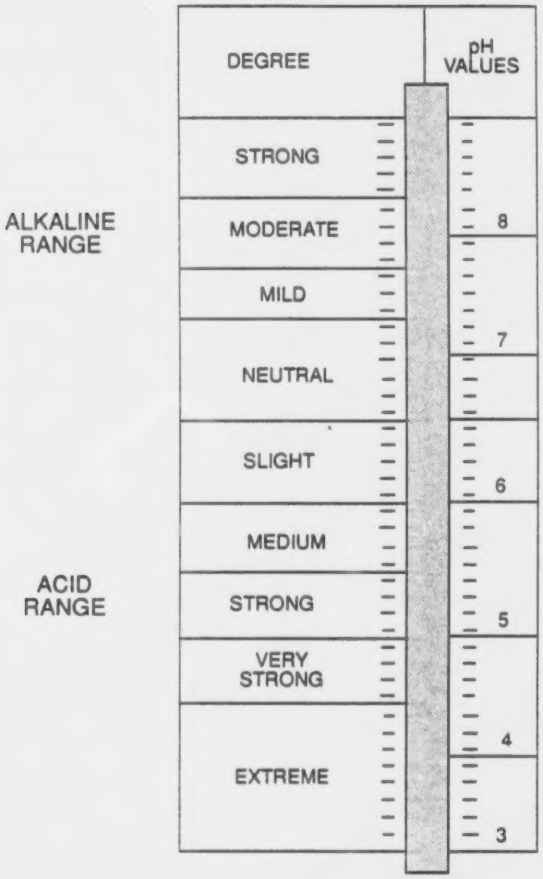
Volume Composition of Average Soil



The volume composition of a loam soil in good tilth is approximately 50 percent solids (mineral/organic) and 50 percent pore space. When the soil moisture is adequate for normal plant growth, approximately half of the pore space will be filled with water and the other half with air. (Courtesy, Vocational Instructional Services, Texas A&M University)

TRANSPARENCY MASTER #2

pH Scale


DEGREE
pH VALUES
ALKALINE RANGE
STRONG
MODERATE
MILD
NEUTRAL
ACID RANGE
SLIGHT
MEDIUM
STRONG
VERY STRONG
EXTREME
8
7
6
5
4
3

Soil pH usually ranges from 3 to 9, as shown here. Most plants grow best in a pH range between about 6.0 to 7.0.

TRANSPARENCY MASTER #3

Why Soils Are Important

1. Plants grow in and on soil.
2. Plants support animal life.
3. Plants and animals support human life.
4. World population is rapidly increasing.
5. A large part of the world's population has inadequate nutrition.
6. World supply of productive soil is limited.
7. Improved soil management could feed more people.

TRANSPARENCY MASTER #4

Why Soils Become Acidic

In humid regions, soils either are acid or are becoming acid when the content of calcium and magnesium is naturally low, is being removed, or is being neutralized.

Acid parent materials are naturally low in calcium and magnesium.

Acid rainfall, moving through the soil, leaches calcium and magnesium out of root zone.

Harvested crops deplete the soil of calcium and magnesium.

Most fertilizers are acid-forming, and the most popular ones are the most acid.

Erosion removes surface soils that contain calcium and magnesium.

To decrease the alkalinity (or lower the pH) of a soil, aluminum sulfate is added.

To decrease the acidity (or raise the pH) of a soil, some form of lime is added.

TRANSPARENCY MASTER #5

Fertilizer Grade

Manufacturer guarantees that analysis contains

5 - 20 - 20

20% available Phosphate (P_2O_5)

5% Total Nitrogen (N) 20% Water-soluble Potash (K_2O)

Remaining 55% consists of other elements necessary to stabilize the chemical compounds and filler.

Question: If you applied 5-20-20 at 100 lbs per acre, how many lbs of N, P_2O_5, K_2O, and filler/elements was applied per acre?

N	P_2O_5	K_2O	Filler/ Elements
100	100	100	100
x .05	x .2	x .2	x .55
5	20	20	55

TRANSPARENCY MASTER #6

Types of Organic Fertilizers

Crop Residues

Animal Manures

Sewage Sludge

Septage

Compost

Municipal, Food Processing, and Industrial Organic Residues

Peat

STUDENT ACTIVITIES

STUDENT WORKSHEET #1 — Macronutrients and Micronutrients and Their Influence on Plants

STUDENT WORKSHEET #2 — Plant Nutrients Word Search (with solution)

STUDENT WORKSHEET #3 — Fertilizer Grades

STUDENT WORKSHEET #4 — Soil Sampling

STUDENT WORKSHEET #5 — Soil Test Report

STUDENT WORKSHEET #6 — Soil pH

STUDENT WORKSHEET #7 — Phosphorus and Potassium

STUDENT WORKSHEET #8 — Types of Organic Fertilizers

For additional activities, teachers may refer to the "Suggested Teaching Activities and Procedures" section in the Instructor's Guide.

STUDENT WORKSHEET #1

Macronutrients and Micronutrients and Their Influence on Plants

On the worksheet below, students should list effects of specific nutrients on plants.

Nitrogen

Phosphorus

Potassium

Calcium

Magnesium

Sulfur

Iron

Manganese

Zinc

Copper

Boron

Molybdenum

Chlorine

STUDENT WORKSHEET #2

Plant Nutrients Word Search

C	I	D	O	O	T	N	E	G	O	R	T	I	N	V	E	Y	D	L	E
O	T	I	N	A	E	W	Q	P	V	V	D	A	Z	O	P	X	H	U	N
F	A	P	T	F	S	K	V	L	M	F	O	A	D	R	N	R	O	O	G
D	G	H	I	N	T	O	D	P	N	O	U	D	I	I	E	A	G	S	C
A	T	O	C	K	V	J	R	G	O	Z	L	M	I	P	R	J	C	L	X
I	G	S	A	E	F	K	L	C	I	T	A	Y	P	N	W	O	M	J	U
V	S	P	A	U	S	I	E	N	A	R	A	O	B	G	O	I	N	U	S
B	T	H	C	M	W	E	C	I	Y	M	C	S	P	D	C	M	O	E	K
F	N	O	B	B	Z	Z	N	M	P	D	Y	T	S	R	E	A	V	T	K
S	E	R	X	I	N	Z	A	A	I	L	G	R	O	I	C	N	U	C	F
K	I	U	H	L	A	C	R	V	G	M	N	N	A	J	U	Q	U	D	N
U	R	S	C	N	R	M	Q	U	U	N	U	C	Q	D	Y	M	Q	M	G
L	T	X	X	O	O	O	U	I	F	T	A	L	H	I	N	M	K	M	U
Q	U	M	S	S	X	R	S	I	R	L	J	M	K	L	R	O	X	R	U
X	N	O	B	T	F	E	O	I	C	H	U	E	R	W	O	J	C	C	A
R	O	L	J	S	N	I	E	B	R	L	P	S	L	Y	M	R	G	E	L
F	R	B	Q	G	L	N	I	W	C	T	A	L	M	R	Z	H	I	S	S
T	C	L	A	D	T	Y	D	G	V	P	I	C	P	G	A	Z	B	N	A
R	A	M	R	S	J	E	G	Z	J	N	M	T	E	Z	S	N	S	D	E
F	M	J	I	E	L	V	W	D	M	I	Q	B	B	P	D	X	N	J	Q

The following words are hidden in the puzzle:

Boron
Calcium
Chlorine
Copper
Iron
Macronutrients
Magnesium
Manganese
Micronutrients
Molybdenum
Nitrogen
Phosphorus
Potassium
Primary Macros
Secondary Macros
Sulfur
Zinc

884

STUDENT WORKSHEET #2 — Key

Plant Nutrients Word Search

•	•	•	•	•	•	N	E	G	O	R	T	I	N	•	•	•	•	•	•
•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	P	•	•	•	•
•	•	P	•	•	S	•	•	•	M	•	•	•	•	R	•	R	•	•	•
•	•	H	•	•	•	O	•	P	•	O	•	•	I	I	E	•	•	•	•
•	•	O	•	•	•	•	R	•	O	Z	L	M	•	P	R	•	•	•	•
•	•	S	•	E	•	•	•	C	I	T	A	Y	P	•	•	O	M	•	•
•	S	P	•	•	S	•	•	N	A	R	A	O	B	•	•	I	N	•	•
•	T	H	•	•	•	E	C	•	Y	M	C	S	•	D	C	•	•	•	•
•	N	O	•	•	•	•	N	M	•	•	Y	•	S	R	E	•	•	•	•
•	E	R	•	•	•	•	A	A	•	•	•	R	O	I	•	N	•	•	•
•	I	U	•	•	•	C	R	•	G	M	•	N	A	•	U	•	U	•	•
•	R	S	•	N	R	M	•	U	U	N	U	C	•	D	•	M	•	M	•
•	T	•	•	O	O	•	U	I	F	T	A	•	H	•	N	•	•	•	•
•	U	•	S	•	•	R	S	I	R	L	•	M	•	L	•	O	•	•	•
•	N	•	•	•	•	E	O	I	C	•	U	•	•	•	O	•	C	•	•
•	O	•	•	•	N	•	E	B	•	L	•	S	•	•	•	R	•	E	•
•	R	•	•	G	•	N	•	•	•	•	A	•	•	•	•	•	I	•	S
•	C	•	A	•	T	•	•	•	•	•	•	C	•	•	•	•	•	N	•
•	A	M	•	S	•	•	•	•	•	•	•	•	•	•	•	•	•	•	E
•	M	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•

The following words are hidden in the puzzle:

Boron
Calcium
Chlorine
Copper
Iron
Macronutrients
Magnesium
Manganese
Micronutrients

Molybdenum
Nitrogen
Phosphorus
Potassium
Primary Macros
Secondary Macros
Sulfur
Zinc

885

STUDENT WORKSHEET #3

Fertilizer Grades

For each of the following fertilizer grades, calculate the following:

a. pounds of N/acre
b. pounds of P_2O_5/acre
c. pounds of K_2O/acre
d. pounds of filler and other elements/acre

Show all calculations!

1. 16 - 8 - 8 at 150 lbs per acre

2. 0 - 0 - 60 at 200 lbs per acre

3. 18 - 46 - 0 at 150 lbs per acre

4. 10 - 10 - 10 at 225 lbs per acre

5. 25 - 20 - 15 at 150 lbs per acre

6. 36 - 24 - 16 at 135 lbs per acre

7. 33 - 24 - 4 at 100 lbs per acre

8. 28 - 34 - 10 at 155 lbs per acre

STUDENT WORKSHEET #4

Soil Sampling

1. List four reasons for taking soil samples:

a. ______________________________
b. ______________________________
c. ______________________________
d. ______________________________

2. What does a soil test show?

a. ______________________________
b. ______________________________
c. ______________________________

3. What other techniques are used to evaluate fertilizer responses?

a. ______________
b. ______________
c. ______________
d. ______________
e. ______________
f. ______________
g. ______________

4. What factors influence the number of samples taken from an area or field?

a. ______________________________
b. ______________________________
c. ______________________________
d. ______________________________
e. ______________________________

5. Describe some pitfalls to avoid in obtaining a good soil sample.

a. ______________
b. ______________
c. ______________
d. ______________
e. ______________
f. ______________
g. ______________

6. Describe the procedure to follow when collecting a soil sample.

a. ______________________________
b. ______________________________
c. ______________________________
d. ______________________________
e. ______________________________
f. ______________________________
g. ______________________________

7. Why is information about past history included with the sample?

a. ______________________________
____
b. ______________________________
____

8. When and how often should a soil sample be taken?

   a.

   b.

   c.

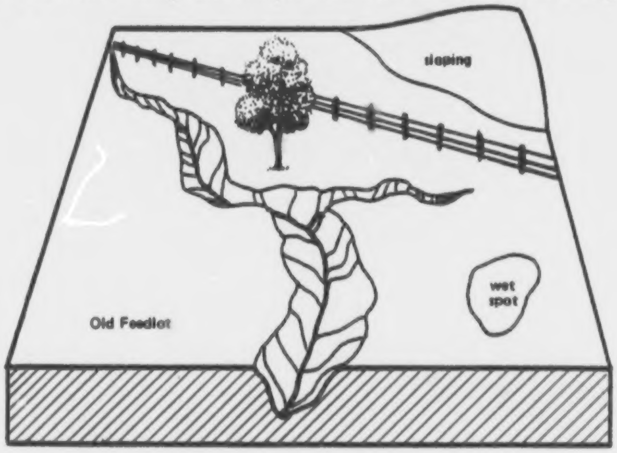
9. What soil testing services are locally available?

   a.
   b.
   c.

10. What equipment is needed to take a soil sample?

    a.
    b.
    c.
    d.

11. Place a small number where each composite sample would be taken in the 20 acre plot below.



12. Sketch a diagram of how you would obtain one composite sample.

STUDENT WORKSHEET #4 — Key

Soil Sampling

1. List four reasons for taking soil samples:

   a. *Make more efficient use of resources.*
   b. *Maintain high fertility level.*
   c. *Avoid applying wrong elements.*
   d. *Determine best rate of fertilizer application to improve crop yields.*

2. What does a soil test show?

   a. *pH level*
   b. *phosphorus level*
   c. *potassium level*

3. What other techniques are used to evaluate fertilizer responses?

   a. *Plant and tissue tests*
   b. *Observed deficiency symptoms*
   c. *Research data*
   d. *Demonstration plots*
   e. *Fertilization guides*
   f. *Knowledge of nutrient removal by crops*
   g. *Past crop responses to fertilizer*

4. What factors influence the number of samples taken from an area or field?

   a. *Slope, color, texture, structure of soils*
   b. *Erosion*
   c. *Past treatments*
   d. *Cropping system*
   e. *Land use history*

5. Describe some pitfalls to avoid in obtaining a good soil sample.

   a. *Don't mix different soil types.*
   b. *Don't use dirty or oily tools.*
   c. *Don't artificially dry samples.*
   d. *Don't take sample from fertilizer band.*
   e. *Don't take samples from fence rows, dead furrows, etc.*
   f. *Don't sample below plow depth.*
   g. *Don't lose the map of sampling areas.*

6. Describe the procedure to follow when collecting a soil sample.

   a. *Use soil auger, soil tube, spade or trowel.*
   b. *Remove surface trash.*
   c. *Use center half-inch of spade's slice.*
   d. *Use recommended number of sampling areas.*
   e. *Sample to plow depth.*
   f. *Use clean containers.*
   g. *Mix thoroughly and place in marked bags.*

7. Why is information about past history included with the sample?

   a. *It provides information about practices used which might influence fertility responses.*
   b. *Former yield information and future goals are needed to provide an appropriate fertility recommendation.*

8. When and how often should a soil sample be taken?

   a. *Every 4-6 years*
   b. *Before tillage or soil treatments*
   c. *In fall for spring planted crops and in summer for fall planted crops*

9. What soil testing services are locally available?

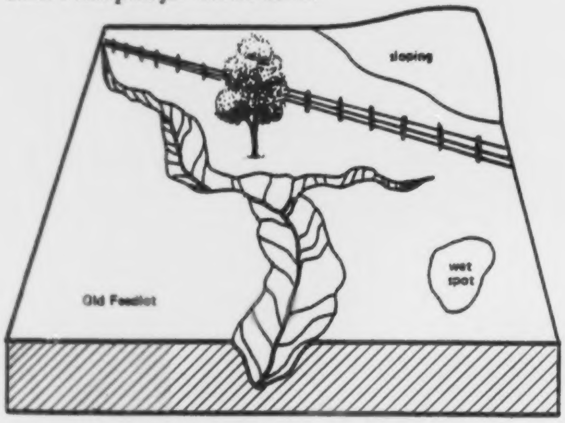
   a. *Illinois Soil Testing Laboratories*
   b. *Farm Service Dealers*
   c. *Other: schools and private institutions*

10. What equipment is needed to take a soil sample?

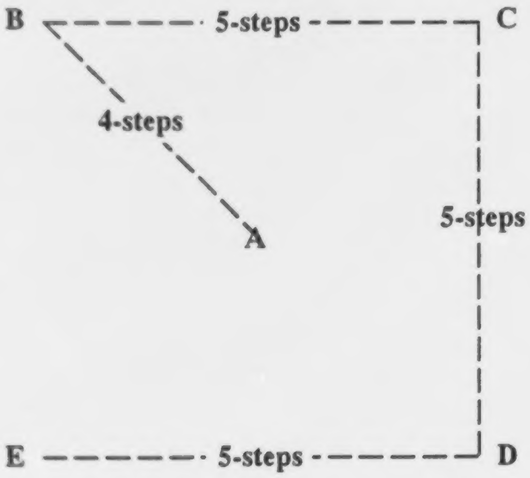
    a. *Small sacks*
    b. *Pan or bucket*
    c. *Probe, auger, or spade or trowel*
    d. *Box for carrying samples*

11. Place a small number where each composite sample would be taken in the 20 acre plot below.

    There are many combinations, but avoid the tree, eroded area, and fence row. Sample separately old feedlot, wet spot, and sloping area. Take 7 samples for the 20 acres.



12. Sketch a diagram of how you would obtain one composite sample.



STUDENT WORKSHEET #5

Soil Test Form D-1

SOIL TEST REPORT

_____________County

Samples brought in by_____________

Date: _____________ (received) _____________ (tested)

Samples tested by_____________

Tenant: _____________ Address: _____________

Owner: _____________ Address: _____________

This report gives you the results of the laboratory tests on your samples.

I suggest that you *keep this report in a permanent folder. Record right on the field maps* the amounts of lime and fertilizer that you apply and the dates when you apply them. This record will help you to interpret the next test on the field and will also give you a long-term inventory that will show whether soil fertility is being built up, is being maintained, or is declining.

Field and sample number	Acres	pH Test for acidity	P_1 Test for available phosphorus	K Test for potassium	Organic matter or soil color	Comments

Soil tests are only a means to an end. The important thing is how you use the results to plan a better soil-fertility program. Planning the most profitable soil treatments after you have the results of the soil tests is not simple, but it is extremely important in determining your profit from farming.

On the back of this sheet, and on the other sheets labeled LIME, PHOSPHORUS, or POTASSIUM, you will find the information that you need to understand the tests so that you can plan a more profitable soil-fertility system. If you have further questions, please contact me.

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STUDENT WORKSHEET #6

Soil pH

1. Name the three major elements necessary for plant growth.

   a. ______________________________

   b. ______________________________

   c. ______________________________

2. Why do soils become acidic or alkaline?

3. The most important single chemical characteristic of a soil is the degree of __________ or __________.

4. The soil reaction is indicated by ______________.

5. A soil with a pH of 6.0 is considered ____________. Alkaline soils have a pH greater than __________.

6. The most desirable pH range for farm crops is ___________ to ___________.

7. List four crops that grow best in the following pH ranges:

pH	5.0-5.5	5.5-6.0	6.0-6.5	6.5-7.5
	a. __________	a. __________	a. __________	a. __________
	b. __________	b. __________	b. __________	b. __________
	c. __________	c. __________	c. __________	c. __________
	d. __________	d. __________	d. __________	d. __________

8. The best way to keep check on soil acidity levels is by ___________.

9. List the three most commonly used liming materials for neutralizing soils.

   a. ______________________________

   b. ______________________________

   c. ______________________________

STUDENT WORKSHEET #6 — Key

Soil pH

1. Name the three major elements necessary for plant growth.

   a. *Nitrogen*

   b. *Phosphorus*

   c. *Potassium*

2. Why do soils become acidic or alkaline?

   Fluctuations in hydrogen ions in the soil

3. The most important single chemical characteristic of a soil is the degree of *acidity* or *alkalinity*.

4. The soil reaction is indicated by *pH scale*.

5. A soil with a pH of 6.0 is considered *acid*. Alkaline soils have a pH greater than *7.0*.

6. The most desirable pH range for farm crops is *6.0* to *7.0* .

7. List four crops that grow best in the following pH ranges:

pH	5.0-5.5	5.5-6.0	6.0-6.5	6.5-7.5
	a. *Azaleas*	a. *Bermuda grass*	a. *Apples*	a. *Alfalfa*
	b. *Camellias*	b. *Tall fescue*	b. *Barley*	b. *Cabbage*
	c. *Irish potato*	c. *Oats*	c. *Corn*	c. *Ladino clover*
	d. *Watermelons*	d. *Peaches*	d. *Soybeans*	d. *Red clover*
		e. *Millet*	e. *Sweet corn*	e. *Sweet clover*
		f. *Rye*	f. *Wheat*	f. *White clover*
		g. *Strawberries*	g. *Vetch*	
			h. *Sorgum*	
			i. *Kentucky bluegrass*	
			j. *Lespedeza*	
			k. *Crimson clover*	

8. The best way to keep check on soil acidity levels is by *soil testing*.

9. List the three most commonly used liming materials for neutralizing soils.

   a. *Limestone - Ag Lime*

   b. *Superphosphate*

   c. Calcium nitrate, Calcium sulfate, or Calcium cyanamid

STUDENT WORKSHEET #7

Phosphorus and Potassium

1. Name nine common sources of phosporus and their approximate percentage of phosphorus.

Name	%
a. ________________________________	______
b. ________________________________	______
c. ________________________________	______
d. ________________________________	______
e. ________________________________	______
f. ________________________________	______
g. ________________________________	______
h. ________________________________	______
i. ________________________________	______

2. List six sources of potassium and their approximate percentage of potassium.

Name	%
a. ________________________________	______
b. ________________________________	______
c. ________________________________	______
d. ________________________________	______
e. ________________________________	______
f. ________________________________	______

3. The three forms of potassium in soil are:

a. ________________________________

b. ________________________________

c. ________________________________

4. What effect does pH have on the availability of phosphorus and potassium?

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5. A survey of fields in Illinois showed about 16% were unrealistically high in their P_1 test. What are some possible explanations for these results?

6. What is the phosphorus-supplying power of the soil in your region of Illinois?

7. To increase the P_1 test one pound, you must apply ________ pounds of P_2O_5 per acre.

8. What is the potassium-supplying power of the soil in your region of Illinois?

9. To increase the soil potassium test one pound, you must apply how many pounds of K_2O?

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STUDENT WORKSHEET #7 — Key

Phosphorus and Potassium

1. Name nine common sources of phosporus and their approximate percentage of phosphorus.

	Name	%
a.	*Superphosphate*	*16-22*
b.	*Triple superphosphate*	*42-50*
c.	*Liquid phosphoric acid*	*54*
d.	*Nitric phosphate*	*10-22*
e.	*Colloidal phosphate*	*20*
f.	*Basic slag*	*8-12*
g.	*Ammonium phosphate*	*20-39*
h.	*Monophosphate*	*48*
i.	*Diammonium phosphate*	*48-53*

2. List six sources of potassium and their approximate percentage of potassium .

	Name	%
a.	*Potassium chloride (muriate)*	*60*
b.	*Potassium sulfate*	*50*
c.	*Potassium nitrate*	*44*
d.	*Potassium-magnesium sulfate*	*22*
e.	*Potassium-sodium nitrate*	*14*
f.	*Potassium phosphate*	*48*

3. The three forms of potassium in soil are:

   a. *Soil Solution*
   b. *Exchangeable K*
   c. *Storehouse form*

4. What effect does pH have on the availability of phosphorus and potassium?

   Acid and alkaline conditions limit phosphorus. Acid conditions limit potassium.

5. A survey of fields in Illinois showed about 16% were unrealistically high in their P_1 test. What are some possible explanations for these results?

   Poor sampling procedures; improper fertilizer applications; representation of only a small area in the field

6. What is the phosphorus-supplying power of the soil in your region of Illinois? *Answers will vary.*

7. To increase the P_1 test one pound, you must apply *9* pounds of P_2O_5 per acre.

8. What is the potassium-supplying power of the soil in your region of Illinois? *Answers will vary.*

9. To increase the soil potassium test one pound, you must apply how many pounds of K_2O? *4*

STUDENT WORKSHEET #8

Types of Organic Fertilizers

Fill in a description of each organic fertilizer.

Crop Residue

Animal Manures

Sewage Sludge

Septage

Compost

Peat

Municipal, Food Processing, and Industrial Organic Residues

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Preventing Soil Erosion and Managing Land

RELATED PROBLEM AREA(S):

1. Understanding Basic Soil Science Principles (Central Core Cluster)

2. Classifying Soils

PREREQUISITE PROBLEM AREA(S):

1. Understanding Basic Soil Science Principles (Central Core Cluster)

LEVEL: Preparatory

OCCUPATIONAL TASKS ADDRESSED:

Agricultural Business and Management Cluster

Duty K: Maintaining and Constructing Structures

1. Layout conservation structures using transit
2. Perform maintenance inspection of facilities

Duty L: Growing Corn, Soybeans, Small Grains, or Forage Crops

1. Plan planting schedules
2. Prepare seedbed
3. Select planting method
4. Select seed varieties
5. Select planting data
6. Plant seeds
7. Select pest control program
8. Monitor plant depth
9. Spray crop for pest control
10. Cultivate crop

Duty H: Managing the Business

1. Develop land use program

Horticulture Cluster

Duty C: Controlling the Plant Environment

1. Plan conservation practices

Duty K: Maintaining and Improving Grounds

1. Aerify turf
2. Verticut turf
3. Mow grounds
4. Sod worn spots in lawn

Duty Q: Managing the Business

1. Develop land use program

Agricultural Resources Cluster

Duty A: Managing the Recreational Facility

1. Determine land use capability
2. Assist in development of resource conservation plans

Duty B: Applying Laws, Regulations, and Policies

1. Interpret stream, lake, pond and ground water laws
2. Perform preventative and scheduled maintenance activities on grounds and facilities

STATE GOALS FOR LEARNING:

In planning the instruction for this problem area, teachers can promote the development of several student learning objectives which are related to the State Goals for Learning in Biological and Physical Sciences and Social Sciences. These objectives are listed on the Learning Assessment Plan forms included on the following page(s). Those learning objectives marked with an asterisk (*) are taken from the sample lists provided by the Illinois State Board of Education.

CORE

Illinois Agricultural Core Curriculum

Agricultural Education 124 Mumford Hall 1301 W. Gregory Drive University of Illinois Urbana, IL 61801

Director: Dale A. Law, Ed.D.
Principal Investigator: Jerry D. Pepple, Ed.D.
Research Assistant: Randy J. Bernhardt

Submission Date ____________
☐ Original submission ☐ Revision
Page ____ of ____

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

(Affix label or complete district information.)
COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐
District Name
City

I. LEARNING AREA *(check one)*
☐ Language Arts
☐ Mathematics
☒ Sciences
☐ Fine Arts
☐ Social Sciences
☐ Physical Development/Health

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will have a working knowledge of the concepts and basic vocabulary of biological, physical, and environmental science and their application to life and work in contemporary technological society.

Contact Person: ____________
Title: ____________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Know how weathering, heating, cooling, and erosion change the surface of the earth.					
*2. Identify several ways that people's activities accelerate soil erosion.					
3. Know five major types of soil erosion by water.					
4. Explain the process of wind erosion.					
5. Know the six areas that will either assist or inhibit erosion.					
6. Explain the effects of erosion.					
-900					901

ISBE 41-78 (1/88)

Submission Date ____________

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Page ____ of ____

I. LEARNING AREA *(check one)*

☐ Language Arts ☐ Fine Arts

☐ Mathematics ☒ Social Sciences

☐ Sciences ☐ Physical Development/Health

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)

COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐

District Name

City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to demonstrate a knowledge of world geography with emphasis on the United States.

Contact Person: ____________

Title: ____________

Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Understand why humans generally attempt to control the quality and use of the natural environment.					
*2. Know the reasons for different kinds of land use.					
3. Develop an understanding of methods of controlling soil erosion by water and wind.					
902					903

ISBE 41-78 (1/86)

Illinois Agricultural Core Curriculum Rev.

Preventing Soil Erosion and Managing Land

Agricultural Business and Management
Plant and Soil Science

Submission Date ____________
☐ Original submission ☐ Revision
Page ____ of ____

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)

COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐

District Name

City

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☒ Sciences ☐ Physical Development/Health

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will have a working knowledge of the social and environmental implications and limitations of technological development.

Contact Person: ____________
Title: ____________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Relate farming practices to soil conservation.					
2. Define conservation.					
3. Explain secondary benefits of soil conservation.					

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Preventing Soil Erosion and Managing Land

STUDENT LEARNING OBJECTIVES

Upon completion of their study of this problem area, students will be able to :

1. Define erosion.
2. Define conservation.
3. Know five major types of soil erosion by water.
4. Explain the process of wind erosion.
5. Know the six factors that influence the process of erosion.
6. Explain the effects of erosion.
7. Develop an understanding of methods of controlling soil erosion by water and wind.
8. Explain the secondary benefits of soil conservation.

INSTRUCTOR'S NOTES AND REFERENCES

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INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Preventing Soil Erosion and Managing Land

PROBLEMS AND QUESTIONS FOR STUDY

1. What is erosion?
2. What is conservation?
3. What are the names of the five major types of soil erosion by water?
4. Can you explain or describe each of the five major types of soil erosion by water?
5. What is wind erosion? Can you give a formal definition?
6. What are the six factors that influence the process of soil erosion?
7. After erosion has occurred, what are its effects?
8. How does weathering, heating, cooling, and erosion change the surface of the earth?
9. How does human activity accelerate soil erosion?
10. Why do humans attempt to control the quality and use of the natural environment?
11. What are the different uses of land?
12. What intent or purpose do we have in mind when we incorporate these land uses?
13. What farming practices are related to soil conservation?
14. Can you describe the practices related to soil conservation?
15. What are the primary benefits of soil conservation?
16. What are the secondary benefits of soil conservation?

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Preventing Soil Erosion and Managing Land

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES

1. Begin the problem with an interest approach. For example, discuss the Grand Canyon, which is an extreme case of gully erosion by the Colorado River over hundreds of thousands of years. Or discuss the fact that much of the state of Louisiana was formed by sediment carried downstream by the Mississippi River.
2. Ask students to give you a definition of erosion and conservation. Use Information Sheet #1 for definitions of terms.
3. Use Information Sheet #2 and Transparency Masters #1 and #2 to explain and show students types of erosion caused by water.
4. Perform demonstration laboratory "How Do We Keep It On The Farm: A Lesson in Erosion," on pages 53-64 of *Agricultural Basics in Education, Classroom Lessons on Illinois Agriculture.* Make copies of worksheets to distribute to class. They should answer questions as you conduct the lab experiment.
5. Show Vocational Agriculture Service slidefilm *Soil Erosion — The Silent Enemy of the Soil — Our Precious Resource.* Students should complete Student Worksheet #1 after viewing the slidefilm.
6. Have students conduct a report on observations of soil erosion around their farm, home, or community. The report should include the date, place, and type of erosion.
7. Using Information Sheet #3, define wind erosion and explain the different types of wind erosion.
8. Show Transparency #3, and have students explain each of the six factors that influence the process of soil erosion.
9. Have students answer the question, "After erosion has occurred, what are its effects"? Use Transparency #4 in conjunction with this discussion.
10. Assign Student Worksheet #2 as a homework assignment for students. Completed worksheet is due one day after the next rainfall.
11. Using Transparency Master #5, explain how rock becomes soil through weathering.
12. Show Transparency Master #6. Ask students for their opinions on the statement concerning how man upsets nature's balance.
13. Using Information Sheet #4, Transparency Masters #7 and #8, and Student Worksheet #3, discuss water and wind erosion control measures. Have students include descriptions of each erosion control measure on their worksheet.
14. Supplement lesson on water and wind erosion control measures with the first four items of the VAS Units and Slidefilms listed in the references.
15. Ask students to list the primary advantage and secondary advantages to using soil conservation practices. Use Transparency Master #9 to assist in the discussion.

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Preventing Soil Erosion and Managing Land

REFERENCES

INSTRUCTOR'S NOTES AND REFERENCES

*1. *Resource Conservation Glossary.* (1979). Soil Conservation Society of America, 7515 Northeast Ankeny Road, Ankeny, IA 50021.

*2. *Soil Science Simplified.* (1988). Harpstead, Hole, Bennett. Iowa State University Press, Ames, IA 50010.

3. *Our Natural Resources.* (1982). Kircher and Wallace. Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050.

4. *Our Soils and Their Management.* (1983). Donahue, Follett, Tulloch. Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050.

*5. *Approved Practices in Soil Conservation.* (1982). Bosworth and Foster. Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050.

*6. *Soil Science - Principles and Practices.* (1985). Hausenbuiller, R.L. Wm. C. Brown Publishers, 2460 C Brown Publishers, Dubuque, IA 52001.

7. *Crop Production.* (1984). Delorit, Greub, Ahlgren. Prentice-Hall Inc., 200 Old Tappan Road, Old Tappan, NJ 07675. (800) 223-2348.

*8. *Agricultural Basics in Education, Classroom Lessons on llinois Agriculture.* (1986). Lewis, John L., Project Director. Illinois Council on Economic Education, Northern Illinois University, Dekalb, IL 60115.

*9. *Grass Waterways* (VAS Unit #U4021); *Using Conservation Tillage Systems* (VAS Unit #U4058); *Meet the Speck: The Erosion Crisis* (VAS Filmstrip Set #MF724); *Agriculture: Soil Erosion and Water Quality* (VAS Slide Set #S722); *Soil Erosion: The Silent Enemy of the Soil: Our Precious Resource* (VAS Slide Set #S723A). Vocational Agriculture Service, College of Agriculture, University of Illinois, 1401 S. Maryland Drive, Urbana, IL 61801. (217) 333-3871.

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*Indicates highly recommended reference

INSTRUCTIONAL RESOURCES

These resources are intended for use by teachers in planning and teaching the materials for this problem area and may be adapted to fit the teaching method(s) used.

INFORMATION SHEET #1 — Terms to be Defined

INFORMATION SHEET #2 — Erosion Caused by Water

INFORMATION SHEET #3 — Wind Erosion

INFORMATION SHEET #4 — Water and Wind Erosion Control Measures

TRANSPARENCY MASTER #1 — Erosion Caused By Running Water

TRANSPARENCY MASTER #2 — Soil Detachment by Raindrops

TRANSPARENCY MASTER #3 — Six Factors that Influence the Process of Soil Erosion

TRANSPARENCY MASTER #4 — The Effects of Erosion

TRANSPARENCY MASTER #5 — Formation of Soil

TRANSPARENCY MASTER #6 — How Man Upsets Nature's Balance

TRANSPARENCY MASTER #7 — Water Erosion Control Measures

TRANSPARENCY MASTER #8 — Wind Erosion Control Measures

TRANSPARENCY MASTER #9 — Advantages of Using Soil Conservation Practices

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INFORMATION SHEET #1

Terms to be Defined

Conservation — the protection, improvement, and use of natural resources according to principles that will assure their highest economic or social benefits for people and their environment now and into the future.

Conservation plan — a collection of material containing land-use information requested for making decisions regarding the conservation of soil, water, and related plant and animal resources for all or part of an operating unit.

Conservation practice — a technique or measure used to meet a specific need in planning and carrying out soil and water conservation programs for which standards and specifications have been developed.

Conservation tillage — any tillage sequence that reduces loss of soil or water relative to conventional tillage; often a form of noninversion tillage that retains productive amounts of residue mulch on the surface.

Crop residue — the portion of a plant or crop left in the field after harvest.

Crop residue management — use of that portion of the plant or crop left in the field after harvest for protection or improvement of the soil.

Crop rotation — the growing of different crops in recurring succession on the same land.

Delta — an alluvial deposit formed where a stream or river drops its sediment load upon entering a quieter body of water; formed largely beneath the water surface and in an area resembling the shape of the Greek letter (Δ), with the point of entry of the stream at one corner.

Erosion — the wearing away of the land surface by running water, wind, ice, or other geological agents, including such processes as gravitational creep.

Leached soil — a soil from which most of the soluble materials have been removed from the entire profile or have been removed from one part of the profile and have accumulated in another part.

Leaching — the removal from the soil in solution of the more soluble materials by percolating waters.

INFORMATION SHEET #2

Erosion Caused by Water

Erosion Caused by Running Water

Sheet Erosion — removal of a thin, fairly uniform layer of surface soil. It is the most common type of erosion and the most serious, because it can go unnoticed for a long time.

Gully Erosion — most noticeable type of erosion. Most examples are found near the bottom of a slope. It is caused by a large concentrated volume of water flowing in one low area, and it in turn causes damage to soil and its productivity.

Rill erosion — formation of numerous small channels only several inches deep, occuring mainly on recently cultivated soils; not as severe as gully erosion. As small streams increase in size, they carry more soil away.

Bank Erosion — removal of soil, sand, or rock from the land adjacent to a body of water due to wave action.

Soil Detachment by Raindrops (Splash Erosion)

The impact of raindrops on soils causes the breakup of soil aggregates and splashing soil downslope.

Until recently, agriculturists tried to control erosion by concentrating on runoff.

Originally it was thought that the raindrops just caused surface sealing which caused more runoff.

It has been estimated that during a hard rain storm, as much as 100 tons of soil may be bouncing up and down on each acre.

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INFORMATION SHEET #3

Wind Erosion

Wind erosion — the detachment and transportation of soil by wind.

Types of Wind Erosion

Saltation — particle movement in wind where particles skip or bounce along soil surface; occurs with medium-sized particles.

Suspension — fine soil particles, silt, and clay, suspended in the air resulting in a "dust storm." Particles can be carried long distances by this means.

Surface creep — soil particles rolling on the surface; large particles too heavy for saltation or suspension.

INFORMATION SHEET #4

Water and Wind Erosion Control Measures

Water

Terracing — an embankment or combination of an embankment and channel constructed across a slope to control erosion by diverting and temporarily storing surface runoff instead of permitting it to flow uninterrupted down the slope.

Diversion — a channel, embankment, or other man-made structure constructed to divert water from one area to another.

Grass waterway — a natural or constructed waterway, usually broad and shallow, covered with erosion-resistant grasses, used to conduct surface water from or through cropland.

Ponds and dams — impoundment areas for run-off water.

Drainage systems (tiling) — pipe made of burned clay, concrete, polyvinyl chloride (PVC), or similar material, in various lengths, laid to collect and carry excess water from the soil.

Contour planting — layout of crop in which the farming operations are performed approximately on the contour.

Strip cropping — growing crops in a systematic arrangement of strips or bands which serve as barriers to wind and water erosion.

Conservation tillage — any tillage system that reduces loss of soil or water relative to conventional tillage; often a form of noninversion tillage that retains productive amounts of residue mulch on the surface.

Wind

Strip cropping — See entry on "Water."

Moisture conservation — usually done by leaving crop residue on the surface or using minimum tillage to conserve moisture in the soil.

Emergency cover crop — planting of a close-growing crop that grows quickly in order to prevent wind erosion.; dual purpose as a green manure crop also.

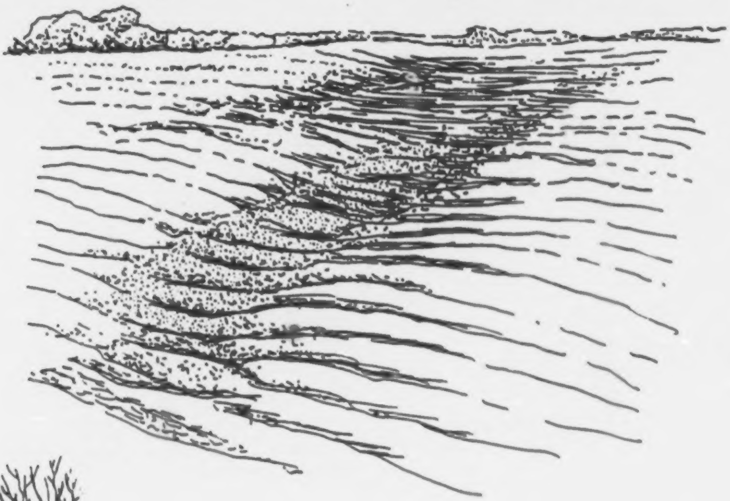
Emergency tillage — working the soil so large clumps of soil are on the surface to prevent wind erosion.

Windbreak — a living barrier of trees or combination of trees and shrubs located adjacent to a farmstead, field, feedlot, or other area to protect soil resources.

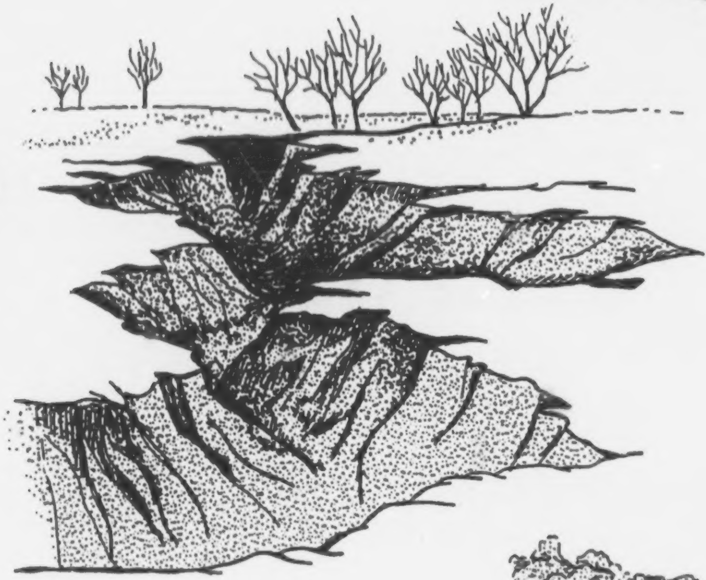
Note to Instructors: Point out that wind erosion is not as serious as water erosion in Illinois.

TRANSPARENCY MASTER #1

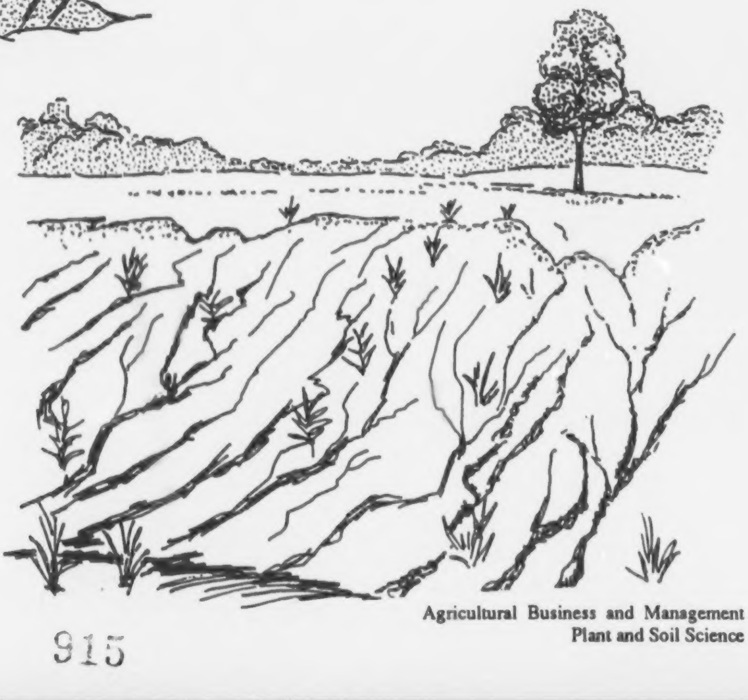
Erosion Caused by Running Water



SHEET EROSION



GULLY EROSION



RILL EROSION

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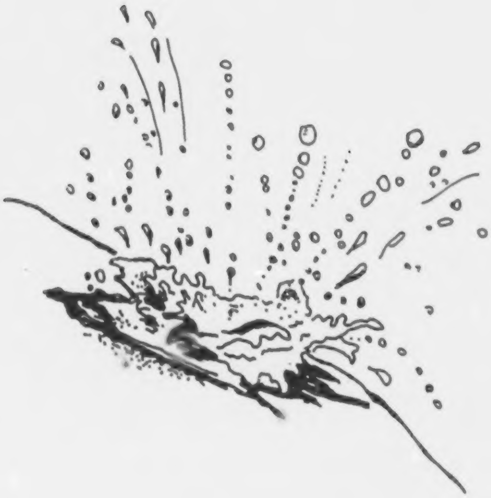
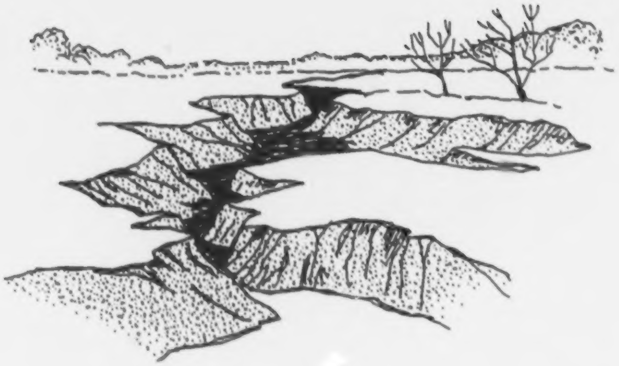
TRANSPARENCY MASTER #2

Soil Detachment by Raindrops



A raindrop may splash soil as far as 5 feet.

One inch of rain may remove one inch of soil per acre (150 tons).



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TRANSPARENCY MASTER #3

Six Factors That Influence the Process of Soil Erosion

1. Topography — How much slope does the land have?
2. Vegetative cover — Is the soil covered with plants most of the time? Is the soil covered or protected during the winter months?
3. Soil structure — Is the soil compacted and of poor structure, thereby preventing rainfall from soaking in?
4. Extent of topsoil — Is there any evidence of sheet erosion? (considerable gravel or pebbles on the soil surface, light-colored, heavy soil)
5. Drainage — Does the soil drain rapidly or slowly? Is it subjected to flooding?
6. Tillage operations — Is the soil often cultivated or tilled to keep the soil loose?

TRANSPARENCY MASTER #4

The Effects of Erosion

1. Loss of best part of the soil.
2. Washing of soils from the rich uplands down to the poorer bottomlands.
3. Loss of nutrients.
4. Lower crop yields.
5. Higher fertilizer applications needed.
6. Siltation of lakes, ponds, dams, and streams.
7. Destruction of roadbanks and ditches.
8. Depletion of soil organic matter.
9. Formation of gullies.

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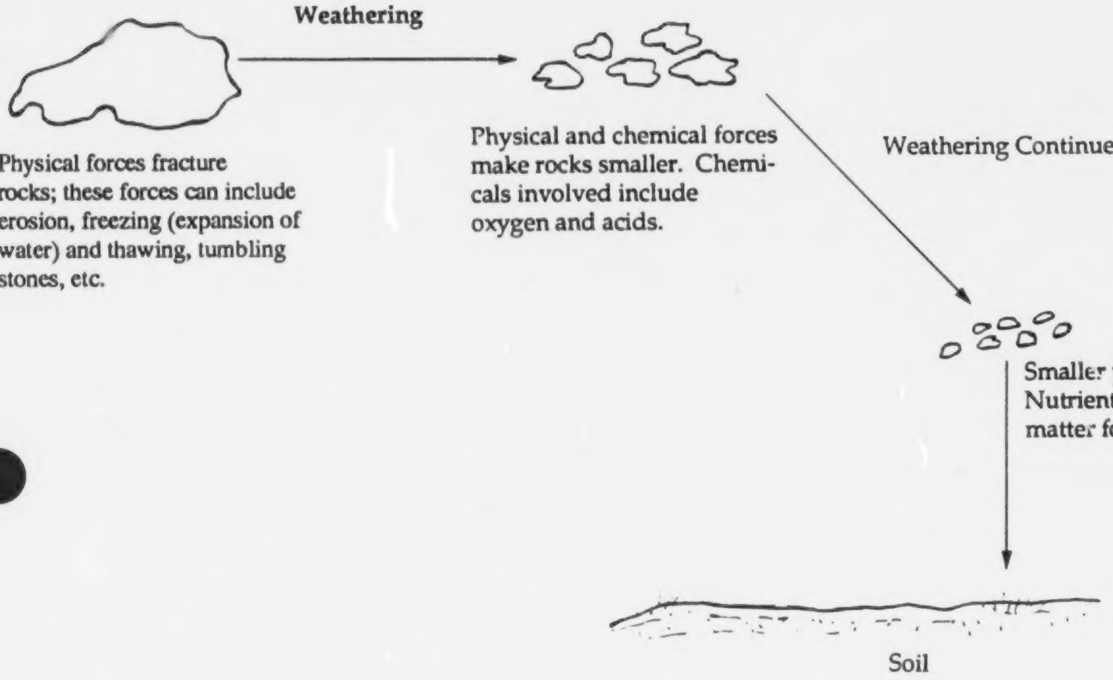
TRANSPARENCY MASTER #5

Formation of Soil



Physical forces fracture rocks; these forces can include erosion, freezing (expansion of water) and thawing, tumbling stones, etc.

Physical and chemical forces make rocks smaller. Chemicals involved include oxygen and acids.

Smaller particles form. Nutrients, humus, organic matter form.

This process takes thousands of years.

TRANSPARENCY MASTER #6

How Man Upsets Nature's Balance

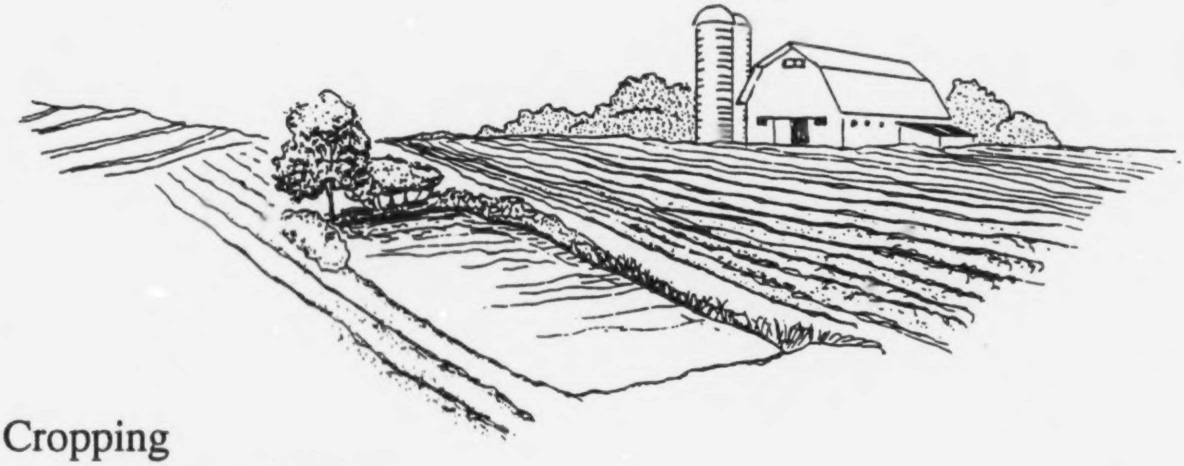
"When man begins to use the soil for agricultural production, he destroys the balance which natural erosion has set up because he substitutes a sparse-growing plant for the natural denser growth and he takes the growth off the soil instead of letting it drop and accumulate over the top of the soil. He uses up the organic matter of the soil by his plowing and seeding operations and makes the soil less porous. His crops take out the plant nutrients which have accumulated in the soil; thus less plant growth is produced, making a thinner covering for the soil. The final result is a washing away of the soil by rains which previously were absorbed or a blowing away through dust storms in the drier parts of the country."

Kircher and Wallace. *Our Natural Resources*. (1982). Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050.

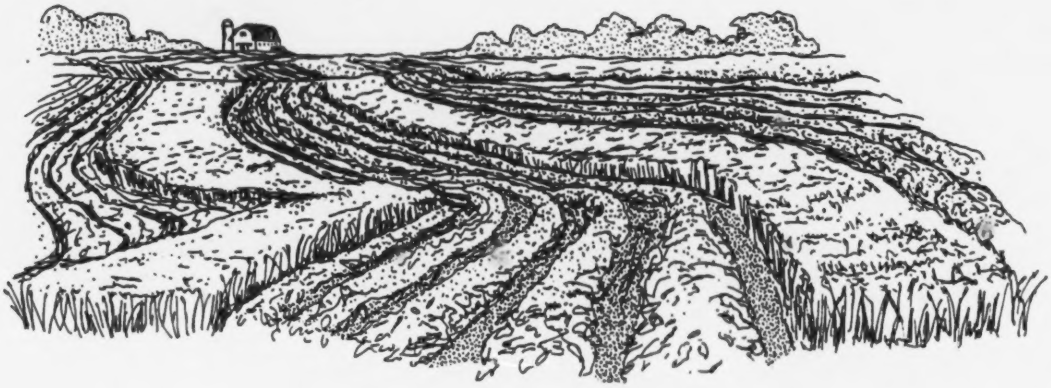
TRANSPARENCY MASTER #7

Water Erosion Control Measures

Mechanical
- Terracing
- Diversions
- Grassed waterways
- Construction of ponds and dams
- Drainage systems (tiling)
- Land preparion



Cropping
- Contour planting
- Strip cropping
- Conservation tillage



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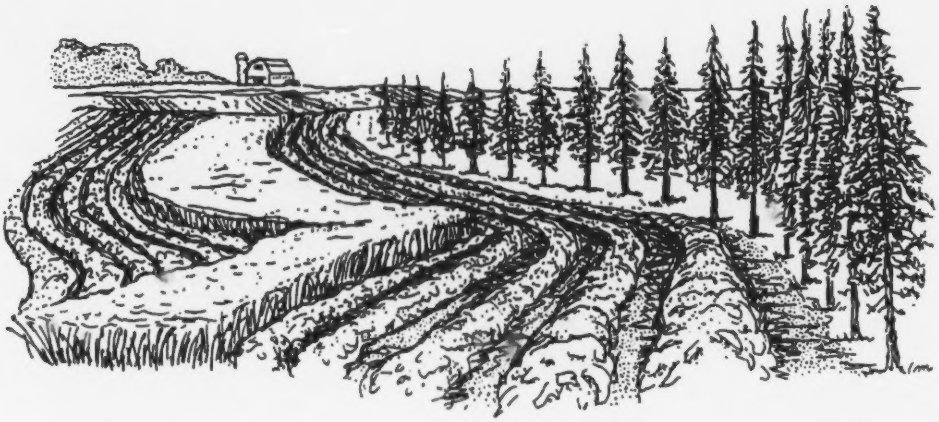
TRANSPARENCY MASTER #8

Wind Erosion Control Measures

1. Strip cropping
2. Prevention of burning
3. Prevention of grazing
4. Moisture conservation
5. Emergency cover crops
6. Emergency tillage operations
7. Windbreak tree planting



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TRANSPARENCY MASTER #9

Advantages of Using Soil Conservation Practices

Primary Advantage:

Dramatically reduces soil erosion and improves the quality of runoff water. Phosphorus loss in runoff from cornfields can be reduced 80 to 90% with conservation tillage methods.

Secondary Advantages:

1. Saves fuel, labor, and machinery costs.
2. Soil tilth and water uptake by the soil are generally maintained or improved.
3. Crop yields, especially corn grain, usually are as large or nearly as large as with conventional tillage. Corn yields often are increased on sandy soils.

STUDENT ACTIVITIES

STUDENT WORKSHEET #1 — Soil and Water Conservation

STUDENT WORKSHEET #2 — Splash Erosion

STUDENT WORKSHEET #3 — Water and Wind Erosion Control Measures

For additional activities, teachers may refer to the "Suggested Teaching Activities and Procedures" section in the Instructor's Guide.

STUDENT WORKSHEET #1

Soil and Water Conservation

References for this worksheet are VAS Unit #U4060 and VAS Slidefilm #S723A.

1. How does man's use of soil as a resource affect society as a whole?

2. In 1934, a national survey was conducted by the Soil Erosion Service and it was found that about ______ acres had lost their top soil and another ________ acres had been severely eroded.

3. In 1977, the SCS identified _____ acres as prime farmland. During the same year, about __________ acres of prime farmland were lost to housing, airports, lakes, reservoirs, etc.

4. Draw a "pie chart" which shows the percent of cropland by slope. (See page 4, VAS Unit #U4060)

5. What factors could account for the general decrease in soil erosion in Illinois between 1930 and 1970?

6. What factors could account for the general increase in soil erosion in Illinois between 1970 and 1980?

7. Today, about _________ tons of soil are lost annually through erosion in Illinois, and about ________ tons of this loss are due to agricultural practices.

8. For every bushel of corn produced in Illinois, the state loses _______ bushels of soil.

9. When soil erosion rates exceed _________ tons per acre per year, it is lost faster than it can be replenished.

10. What soil factors are considered when placing land in one of the eight land classes?

11. In Illinois, most of the crop land erosion comes from which class of land?

12. In Illinois, the land capability class with the highest average erosion rate in tons per acre per year is class ____ ; the class with the lowest is class ___________ .

13. What are two soil erosion processes which result in lower soil productivity?

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14. The erosion process involves what three distinct steps?

15. What are three ways soil is moved by wind?

16. How does surface roughness affect runoff and soil loss?

17. What is meant by "conservation tillage system"?

18. What are some examples of conservation tillage methods used in Illinois?

19. What conservation methods are currently being used in your local county or area?

20. What conservation methods are needed or could be started which would reduce soil and/or water erosion in your local county or area?

21. What are some barriers which keep individuals from practicing soil and water management?

22. What are two "short-term" primary benefits to society of soil conservation?

23. What are two "long-term" benefits to society of soil conservation?

24. What is the long-term goal of the "State Water Quality Plan" in Illinois?

25. What factors are considered in establishing a T-value for land?

STUDENT WORKSHEET #2

Splash Erosion

Purpose:

1. To understand the relationship between raindrops and soil erosion.
2. To compare the effects of plant cover on reducing soil erosion caused by raindrops.
3. To understand the effects of slope and soil erosion caused by raindrops.

Materials:

1. four 1" x 2" x 12" boards sharpened on one end.
2. four 3/8" x 4" x 8" plywood boards painted white.

Procedure:

1. Fasten the painted plywood pieces to the wooden laths.
2. Select locations for soil splash erosion experiments, such as a:
    a. Level, grass-sodded area.
    b. Sloping, grass-sodded area.
    c. Level, bare soil area.
    d. Sloping, bare soil area.
3. Drive boards into ground until bottom of plywood is about 1/4" above ground surface.
4. Keep stakes in place until it rains or, if possible, set up a sprinkler system to simulate at least a 1/4" rain.
5. Have students examine the boards for evidence of soil splash erosion.
6. Promote class discussion on the relationships among rainfall, soil cover, cropping systems, slope of land, soil type, etc.
7. Complete the following form.

Stake #	Location Characteristics	Results

Questions:

1. Which stake location showed the most erosion or soil movement?
2. What types of tillage practice could be used at each location where erosion was evident to reduce the soil loss?
3. Are there other locations around the local community where splash or sheet erosion is taking place? __________ What conservation practices could reduce the erosion?
4. What effects would this type of erosion have on streams, lakes, ponds, etc.
5. Calculate the average soil loss using the universal soil loss equation for one or more of the staked areas.
6. Are these areas within soil loss tolerance limits?

Conclusions:

Identify some approved soil and water conservation practices which could be used on your SAE or on your home farm to reduce soil erosion and water pollution.

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STUDENT WORKSHEET #3

Water and Wind Erosion Control Measures

For each erosion control measure, include a description that will assist you in remembering the control measure.

Water Erosion Control Measures

Terracing

Diversions

Grass Waterways

Ponds and Dams

Drainage Systems (tiling)

Contour Planting

Strip Cropping

Conservation Tillage

Wind Erosion Control Measures

Strip Cropping

Moisture Conservation

Emergency Cover Crops

Emergency Tillage

Windbreaks

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CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Classifying Soils

RELATED PROBLEM AREA(S):

1. Understanding Basic Soil Science Principles (Central Core Cluster)

PREREQUISITE PROBLEM AREA(S):

1. Understanding Basic Soil Science Principles (Central Core Cluster)

LEVEL: Preparatory

OCCUPATIONAL TASKS ADDRESSED:

Agricultural Business and Management Cluster

Duty J: Applying Fertilizers and Chemicals

1. Test soil

STATE GOALS FOR LEARNING:

In planning the instruction for this problem area, teachers can promote the development of several student learning objectives which are related to the State Goals for Learning in Biological and Physical Sciences. These objectives are listed on the Learning Assessment Plan forms included on the following page(s). Those learning objectives marked with an asterisk (*) are taken from the sample lists provided by the Illinois State Board of Education.

Illinois Agricultural Core Curriculum

Agricultural Education 124 Mumford Hall 1301 W. Gregory Drive University of Illinois Urbana, IL 61801

Director: Dale A. Law, Ed.D.
Principal Investigator: Jerry D. Pepple, Ed.D.
Research Assistant: Randy J. Bernhardt

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Agricultural Business and Management
Plant and Soil Science

Submission Date ____________________
☐ Original submission ☐ Revision
Page ____ of ____

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☒ Sciences ☐ Physical Development/Health

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)
COUNTY DISTRICT ESC
District Name
City

II. STATE GOAL FOR LEARNING
As a result of their schooling, students will have a working knowledge of the concepts and basic vocabulary of biological, physical, and environmental sciences and their application to life and work in contemporary technological society.

Contact Person: ____________________
Title: ____________________
Phone: ( )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Recognize the stages in the formation of soil. 2. Understand processes of soil formation.					
3. Define the five general agents or conditions that determine the rate, direction, and extent of soil development.					
4. Classify soil parent material. 5. Identify and explain soil horizons.					
*6. Classify samples of matter by their characteristic physical and chemical properties.					
7. Define three soil classifications according to texture.					
8. Determine soil texture.					
9. Determine how well a soil drains and understand the importance of adequate drainage.					
10. Determine soil structure.					

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date ____________
☐ **Original submission** ☐ **Revision**
Page ____ of ____

(Affix label or complete district information.)

COUNTY	DISTRICT	ESC

District Name

City

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☒ Sciences ☐ Physical Development/Health

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will have a working knowledge of the processes, techniques, methods, equipment and available technology of science.

Contact Person: ____________
Title: ____________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Construct a classification scheme and demonstrate its use.					
2. Conduct a laboratory experiment on soil texture.					
*3. Analyze the results of an experiment.					

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Classifying Soils

STUDENT LEARNING OBJECTIVES

Upon completion of their study of this problem area, students will be able to :

1. Understand processes of soil formation.
2. Define the five general agents or conditions that determine the rate, direction, and extent of soil development.
3. Classify soil parent material.
4. Identify and explain soil horizons.
5. Define three soil classifications according to texture.
6. Determine soil texture.
7. Determine how well a soil drains and understand the importance of adequate drainage.
8. Determine soil structure.
9. Conduct a laboratory experiment on soil texture.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Classifying Soils

PROBLEMS AND QUESTIONS FOR STUDY

1. How does soil form?
2. What are the stages in the formation of soil?
3. What is parent material?
4. What are the physical, chemical, and biological reactions that transform parent material into soil?
5. What are the five general agents or conditions that determine the rate, direction, and extent of soil development?
6. What is climate?
7. How is climate a soil-forming factor?
8. Define topography.
9. Explain how topography is a soil-forming factor.
10. What do living matter and time have to do with the formation of soil?
11. What is soil parent material?
12. What are the types of soil parent material?
13. What are soil horizons?
14. What are the soil classifications according to soil texture?
15. Define sand, silt, and clay textures.
16. What is/are the method(s) of determining soil texture?
17. Why is it important to have adequate soil drainage?
18. How are the drainage capabilities of a soil determined?
19. Define soil structure.
20. How is soil structure classified?

INSTRUCTOR'S NOTES AND REFERENCES

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INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Classifying Soils

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES

1. Begin the problem area with an interest approach which includes an overview of the matter to be studied. Use VAS Unit *Understanding Soils* as an introduction to the unit.

2. Using Information Sheet #1, help students to define terms that are a part of the problem area.

3. With the assistance of Information Sheet #2 and Transparency Master #1, discuss the processes of soil formation.

4. Have students complete Student Worksheet #1.

5. For supervised study, have students read pages 47 - 57 in *Soil Science - Principles and Practices* (see reference list) or any good soil science text that discusses the importance of the five factors (parent material, climate, living matter, topography, and time) on formation of soil. Have students complete Student Worksheet #2 as they read this assignment.

6. Using Information Sheet #3 and Transparency Master #2, discuss with students the five factors of soil formation after they have finished the reading assignment. This will assure that they have included all pertinent information on their worksheet.

7. Using Information Sheet #4 and Transparency Master #3, discuss the importance of having a knowledge of soil parent materials and discuss how soil parent materials are classified.

8. Have students complete Student Worksheet #3 as a homework assignment.

9. Show VAS slide film *Soil Color* and have students complete Student Worksheet #4. Supplement lesson with VAS Unit *Soil Color*.

10. Discuss and explain soil profile/soil horizons. Use Information Sheet #5 and Transparency Master #4.

11. Plan various field trips. Suggestions for possible field trips include:
    a. Visiting a basement construction site to examine soil profile/soil horizons, color, structure, and texture. A pit specially dug for such an examination can also be visited.
    b. Visiting an ASCS conservation project.
    c. Visiting a site where land tile is being installed.

12. Discuss soil texture and the soil textural classes. Explain the use of the soil triangle. Provide a copy of the soil triangle for each student. Refer to Transparency Masters #5 - #8 and VAS Unit *Soil Texture.*

13. Conduct any or all of the laboratory exercises on soil texture with students. Refer to Student Worksheets #5 - #7.

14. Have students complete Student Worksheet #8 as an assignment.

15. Discuss soil porosity and its importance with students. Refer to Information Sheet #6 and Transparency Master #9.

16. Have students conduct a laboratory exercise on Determining Soil Permeability. See Student Worksheet #9.

17. Describe and show illustrations of soil structures. Explain how soil structure is classified, and the four general types of soil structures and their subtypes. Refer to Information Sheet #7 and Transparency Masters #10 and #11.

18. Have students complete Student Worksheet #10.

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Classifying Soils

REFERENCES:

INSTRUCTOR'S NOTES AND REFERENCES

*1. *Soil Science Simplified.* (1988). Harpstead, Hole, Bennett. Iowa State University Press, Ames, IA 50010.

*2. *Soil Science - Principles and Practices.* (1985). Hausenbuiller, R.L. Wm. C. Brown Publishers, Dubuque, IA.

3. *Horticulture: A Basic Awareness.* (1982). Baudendistel, Robert F. Reston Publishing Company, Inc., A Prentice-Hall Company, Reston, VA 22090.

4. *Resource Conservation Glossary.* (1982). Soil Conservation Society of America, 7515 Northeast Ankeny Road, Ankeny, IA 50021.

*5. *Our Soils and Their Management.* (1983). Donahue, Follett, Tulloch. Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050.

*6. *Understanding Soils* (VAS Unit #U4052A); *Soil Color* (VAS Unit #U4029); *Soil Color* (VAS Filmstrip #F708); *Soil Texture* (VAS Unit #U4030). Vocational Agriculture Service, College of Agriculture, University of Illinois, 1401 S. Maryland Drive, Urbana, IL 61801. (217) 333-3871.

*Indicates highly recommended reference

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INSTRUCTIONAL RESOURCES

These resources are intended for use by teachers in planning and teaching the materials for this problem area and may be adapted to fit the teaching method(s) used.

INFORMATION SHEET #1 — Terms to be Defined

INFORMATION SHEET #2 — Processes of Soil Formation

INFORMATION SHEET #3 — Factors of Soil Formation

INFORMATION SHEET #4 — Classification of Soil Parent Materials

INFORMATION SHEET #5 — Soil Profile/Soil Horizons

INFORMATION SHEET #6 — Porosity of Soils

INFORMATION SHEET #7 — Classification of Soil Structure

TRANSPARENCY MASTER #1 — Processes of Soil Formation

TRANSPARENCY MASTER #2 — Factors of Soil Formation

TRANSPARENCY MASTER #3 — Classification of Soil Parent Materials

TRANSPARENCY MASTER #4 — Soil Profile/Soil Horizons

TRANSPARENCY MASTER #5 — Characteristics of the Various Soil Classes

TRANSPARENCY MASTER #6 — The Relative Sizes of Sand, Silt, and Clay Particles

TRANSPARENCY MASTER #7 — Soil Textural Classes

TRANSPARENCY MASTER #8 — Soil Triangle

TRANSPARENCY MASTER #9 — Porosity of Soils

TRANSPARENCY MASTER #10 — Classification of Soil Structure

TRANSPARENCY MASTER #11 — Soil Structure Diagrams

INFORMATION SHEET #1

Terms to be Defined

Climate — sum total of all atmospheric or meteorological influences, principally temperature, moisture, wind, pressure, and evaporation, which combine to characterize a region and give it individuality by influencing the nature of its land forms, soils, vegetation, and land use.

Ions — atoms that are positively charged (cations) because of the loss of one or more electrons, or that are negatively charged (anions) because of a gain in electrons.

Organic matter — the fraction of the soil that includes plant and animal residues at various stages of decomposition, cells and tissues of soil organisms, and substances synthesized by the soil population.

Parent material — unconsolidated mineral or organic matter from which soils are developed.

Soil horizon — layer of soil or soil material approximately parallel to the land surface and differing from adjacent related layers in physical, chemical, and biological properties or characteristics such as color, structure, texture, consistence, pH, etc.

Soil profile — vertical section of the soil from the surface through all its horizons, including C horizons. See soil horizon.

Soil structure — combination or arrangement of individual soil particles into definable aggregates, or peds, which are characterized and classified on the basis of size, shape, and degree of distinctness.

Soil texture — relative proportions of the various soil separates in a soil.

Topography — relative positions and elevations of the natural or man-made features of an area that describe the configuration of its surface.

Topsoil — either (1) layer of soil moved in cultivation, (2) a horizon, or (3) presumably fertile soil material used to top-dress roadbanks, gardens, and lawns.

INFORMATION SHEET #2

Processes of Soil Formation

1. Mineral weathering and clay synthesis — breakdown of coarse mineral grains and their replacement by clay, causing changes in texture, mineralogy, and color of parent materials. This process is most active in warm, moist climates.

2. Organic matter accumulation — accumulation of matter produced from plant-residue decay. Different plants yield different patterns of accumulation. This has a direct effect on color and thickness of the mineral soil (topsoil).

3. Ion exchange — displacement of ions absorbed to clay and humus particles by other ions from the soil solution. In young, weathered soils the predominant ions absorbed are calcium and magnesium (plant nutrients). In humid regions calcium and magnesium are replaced by hydrogen ions which are supplied by rainwater or by biologically produced acids (e.g., organic matter decay).

4. Translocation — movement of a soil component from one level to another in the profile by water. An example is upward movement of soluble salts from ground water, which allows them to accumulate at the soil surface. Translocation of lime, gypsum, silicate clays, humus, iron, and aluminum involves movement of the component out of a horizon at or near the surface and its redeposition in the horizon immediately below.

5. Structure formation — separation by physical forces of an otherwise cohesive mass of soil into aggregates of various sizes and shapes. Forces involved may include the wedging action of plant roots, expanding ice crystals, or contractive forces that cause soil to shrink and crack on drying.

6. Soil mixing — mixing through several means, including the burrowing of insects or worms, shrinking and cracking that lead to drying in clay soils, washing of water over soil surface, soil slippage on slopes, and freezing and thawing.

Note: These processes consist of a combination of physical, chemical, and biological reactions that transform parent material into soil.

INFORMATION SHEET #3

Factors of Soil Formation

Agents or conditions that determine the rate, direction, and extent of soil development.

1. Parent material — Formation of soils starts with and results from changes in parent material. Through its texture and mineralogy, it is a determinant of various physical and chemical attributes of the soil-forming environment.
2. Climate — Precipitation influences the chemical and physical processes involved in mineral weathering, eluviation, and ion movement. Temperature is a measure of the heat available for all physical, chemical, and biological reactions involved in soil development.
3. Living matter — The principal factor in soil formation is vegetation. Growing plants provide a protective cover that limits runoff and erosion while increasing the infiltration of water into the profile.
4. Topography — The configuration of the land surface affects soil formation primarily by modifying climatic influences. Effectiveness of precipitation is influenced by topography due to the amount of runoff. Degree of slope also determines how effectively the sun's rays warm the soil.
5. Time — Determines the total potential for change under an imposed set of environmental conditions.

Note: The first four of these factors determine the nature of the soil-forming environment. The fifth factor, time, determines the extent of change that takes place under an imposed set of environmental conditions.

INFORMATION SHEET #4

Classification of Soil Parent Materials

Three Types of Parent Material

1. Residual Parent Materials — The weathering of consolidated rock produces residual parent material. Residual parent materials are found within stable landscapes where weathering forces have been operating for a long time with a moderate to high intensity.

2. Transported Parent Materials — These materials are also derived from mineral weathering, and are the most widespread of the three types of parent materials. Transported parent materials are of several types, including:

   a. Deposits from Running Water — Sediments deposited from running water are called alluvium. Deposits occur when water loses its velocity and its ability to carry material in suspension.

   b. Marine Sediments — These sediments accumulate in an ocean environment and are later exposed by natural or artificial means while still in an unconsolidated state.

   c. Lacustrine Deposits — These sediments have settled from lake water.

   d. Glacial Deposits — Glaciation has made an important impact on the surface geology in each continent of the Northern Hemisphere. It results from tremendous pressure produced by thick sheets of flowing ice, which cause severe gouging and abrasion of surface rock structures.

   e. Wind-laid Sediments — Extensive deposits of wind-transported materials are found in many parts of the world. They occur in three principal forms: (1) slowly sifting, coarse-textured sand dunes, (2) loess, which consists largely of silt and very fine sand particles, and (3) tephra, which is airborne volcanic material of any size.

   f. Colluvium — This type of parent material is produced by the movement of materials down a slope under the direct influence of gravity. It is sometimes referred to as mass wasting.

3. Organic Deposits — Greatest part of organic parent materials accumulates in lake and swamp water where decomposition of plant residues is retarded by the limited supply of oxygen. It is widely distributed throughout the wetter regions of the world. Highly leached and organic soils are often lacking in some essential plant nutrients and may not support abundant plant growth unless fertilized.

Things That Can be Judged About a Parent Material From Knowledge of its Class

1. Approximate age of the material.

2. Geographic or topographic position of a parent material.

3. Pattern of change of soil over time.

4. Texture of a parent material. (This is sometimes possible.)

INFORMATION SHEET #5

Soil Profile/Soil Horizons

A. A soil profile is a vertical section of soil which extends through all the horizons.

B. Soils can be identified and classified by studying the soil profile.

C. Horizons vary in depth and often mix with one another.

D. Major horizons are A-B-C and these are further divided into:

A_{00} — undecomposed plant and animal material, loose leaves, grass, etc.
A_0 — partially decomposed organic matter
A_1 — dark-colored high organic matter and mineral matter
A_2 — light colored, only found in timber soils
A_3 — changing to B, only found in prairie soils
B_1 — a lot like A_3, sometimes absent
B_2 — high in clay content or iron
B_3 — changing to C or mixed with C

E. The A and B horizons are the major parts of a soil profile.

F. The C horizon is loose parent material.

G. The D horizon is not parent material but can physically affect the characteristics of the soil above it.

INFORMATION SHEET #6

Porosity of Soils

A wet soil is a cold soil that is too low in oxygen for the growth of all major crops except rice. Bacteria, algae, and fungi in a wet soil grow so abundantly that they plug many of the natural openings in the soil through which plant roots would obtain oxygen.

The pore space of soils is filled jointly by air and water, and the higher the water content the lower the amount of space left for the circulation of air through the soil. The freedom of air movement, as it affects the supply of oxygen to the roots and beneficial soil organisms, is critical to plant growth. In general, if the aeration porosity falls much below about 10 percent of the total soil volume, the growth of many plants can be hindered because of the slow rate of delivery of oxygen to the roots.

INFORMATION SHEET #7

Classification of Soil Structure

The classification of soil structure is based largely on shape. There are four general types of structures. These are further divided into subtypes.

1. Platy — evident in the separation of soil into flat, horizontal units of varying thickness.
2. Prismlike — consisting of peds having longer vertical than horizontal axes and surfaces that are comparatively flat.
    a. Prismatic — have either flat or indistinct upper surfaces.
    b. Columnar — have rounded upper surfaces.
3. Blocklike — consisting of peds having vertical and horizontal axes of approximately equal length.
    a. Angular — have bounding surfaces fairly flat and forming sharp corners where they intersect.
    b. Subangular blocky — have both faces and intersects tending to be rounded.
4. Spheroidal — applies mainly to the smallest aggregates. These tend to be rounded but may have irregular surfaces.
    a. Granular — more dense and therefore less porous.
    b. Crumb — less dense and therefore more porous.

TRANSPARENCY MASTER #1

Processes of Soil Formation

1. Continued Mineral Weathering and Clay Synthesis
2. Organic Matter Accumulation
3. Exchange of Ions Absorbed to Clay and Organic Particles
4. Translocation of Solid Soluble Components Within the Profile
5. Structure Formation
6. Mechanical or Biological Mixing

Note: These processes consist of a combination of physical, chemical, and biological reactions that transform parent material into soil.

TRANSPARENCY MASTER #2

Factors of Soil Formation

The Agents or Conditions that Determine the Rate, Direction, and Extent of Soil Development.

1. Parent Material
2. Climate
3. Living Matter
4. Topography
5. Time

TRANSPARENCY MASTER #3

Classification of Soil Parent Materials

Three Types of Parent Material

1. Residual
2. Transported
    a. Deposits from Running Water
    b. Marine Sediments
    c. Lacustrine Deposits
    d. Glacial Deposits
    e. Wind-laid Sediments
    f. Colluvium
3. Organic Deposits

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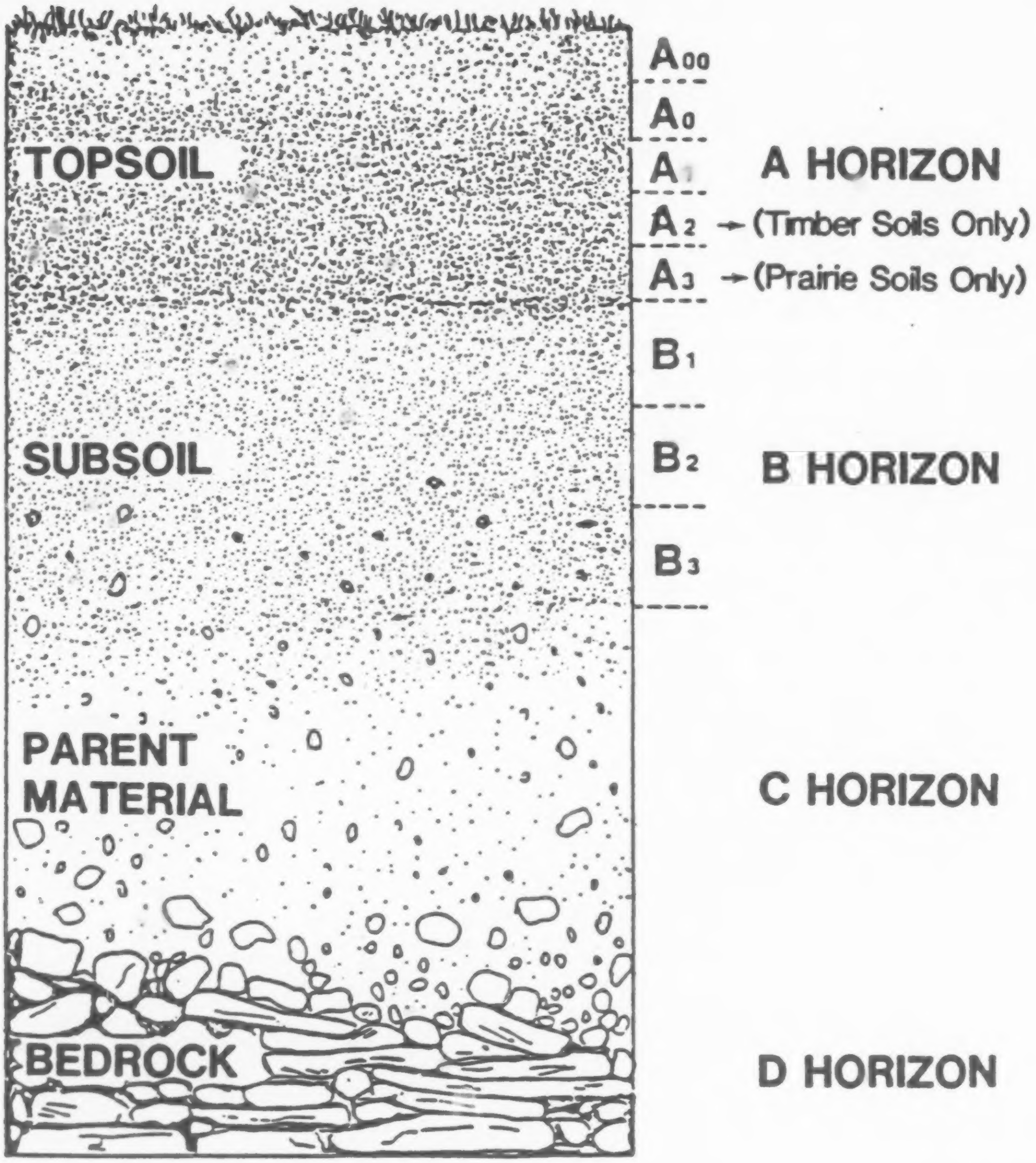
TRANSPARENCY MASTER #4

Soil Profile/Soil Horizons


TOPSOIL
SUBSOIL
PARENT MATERIAL
BEDROCK
A_{00}
A_0
A_1
A_2 → (Timber Soils Only)
A_3 → (Prairie Soils Only)
B_1
B_2
B_3
A HORIZON
B HORIZON
C HORIZON
D HORIZON

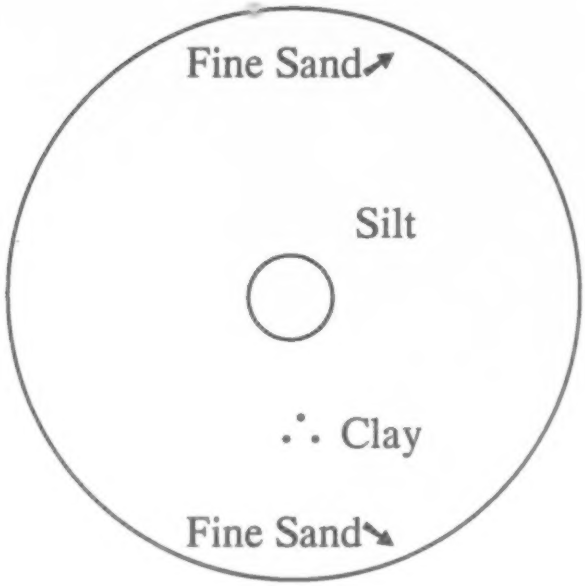
TRANSPARENCY MASTER #5

Characteristics of the Various Soil Classes

Characteristics	Sand	Silt	Clay
Looseness	Good	Fair	Poor
Air Space	Good	Fair to Good	Poor
Drainage	Good	Fair to Good	Poor
Tendency to Form Clods	Poor	Fair	Good
Ease of Working	Good	Fair to Good	Poor
Moisture-Holding Capacity	Poor	Fair to Good	Good
Fertility	Poor	Fair to Good	Fair to Good

TRANSPARENCY MASTER #6

The Relative Sizes of Sand, Silt, and Clay Particles


Fine Sand↗
Silt
Clay
Fine Sand↘

953

TANSPARENCY MASTER #7

Soil Textural Classes

Sand — *Dry*: Loose and single grained; feels gritty. *Moist*: Forms very easily crumbled ball. Sand: 85-100%, Silt: 0-15%, Clay: 0-10%.

Loamy Sand — *Dry*: Silty and clay may mask sand; feels loose, gritty. *Moist*: Feels gritty; forms easily crumbled ball; stains fingers slightly. Sand: 70-90%, Silt: 0-30%, Clay: 0-15%.

Sandy Loam — *Dry*: Clods easily broken; sand can be seen and felt. *Moist*: Moderately gritty; forms ball that can stand careful handling; definitely stains fingers. Sand: 43-85%, Silt: 0-50 %, Clay: 0-20%.

Loam — *Dry*: Clods moderately difficult to break; mellow, somewhat gritty. *Moist*: Neither very gritty nor very smooth; forms a firm ball; stains fingers. Sand: 23-52%, Silt: 28-50%, Clay: 7-27%.

Silt Loam — *Dry*: Clods difficult to break; when pulverized feels smooth, soft and floury, shows fingerprints. *Moist*: Has smooth or slick "buttery" or "velvety" feel; stains figers. Sand: 0-50%, Silt: 50-88%, Clay: 0-27%.

Clay Loam — *Dry*: Clods very difficult to break with fingers. *Moist*: Has slightly gritty feel; stains fingers; ribbons fairly well. Sand: 20-45%, Silt: 15-53%, Clay: 27-40%.

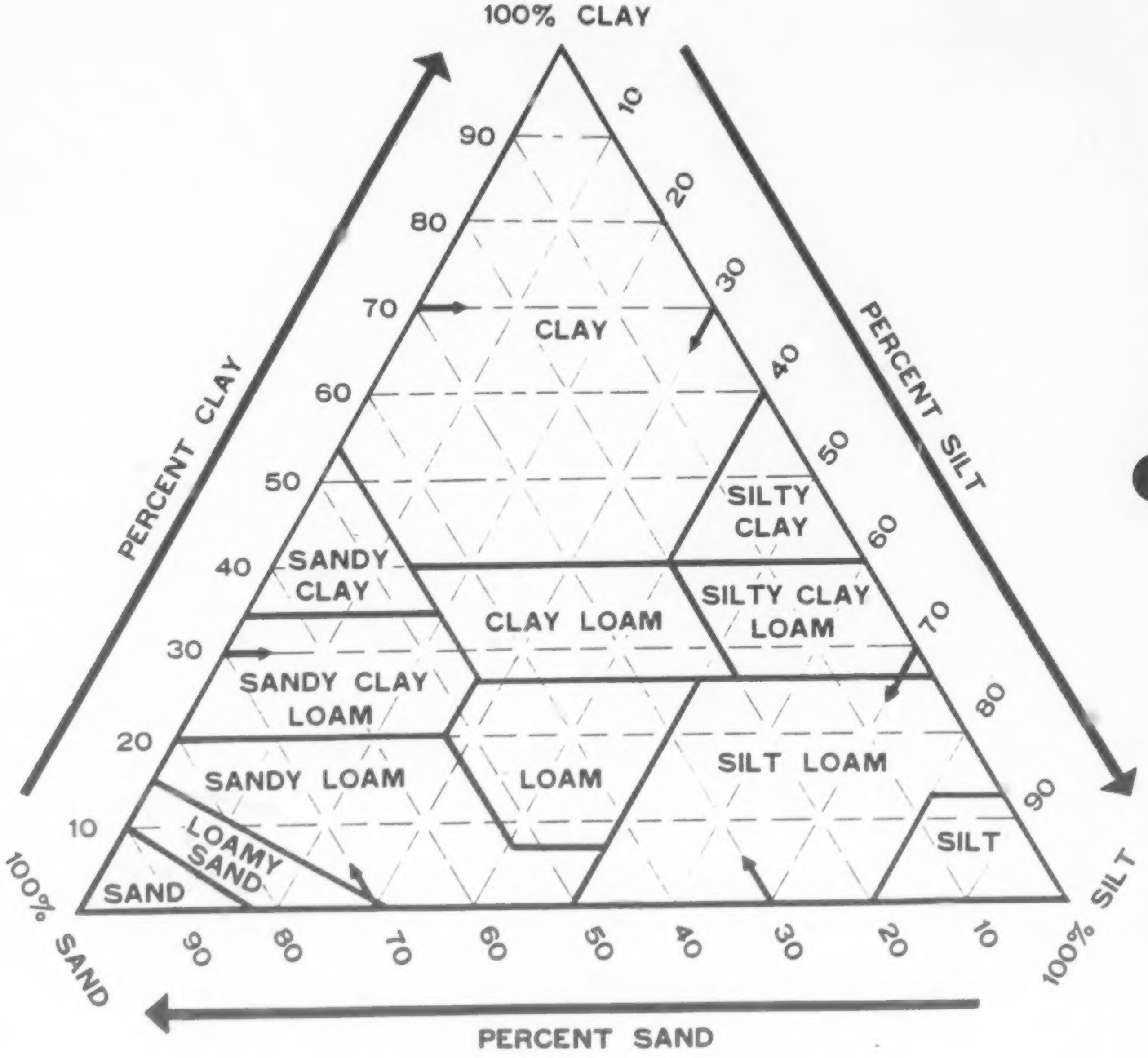
Silty Clay Loam — Same as above but very smooth. Sand: 0-20%, Silt: 40-73%, Clay: 27-40%.

Sandy Clay Loam — Same as for clay loam. Sand - 45-80%, Silt - 0-28%, Clay - 20-35%.

Clay — *Dry*: Clods cannot be broken with fingers without extreme pressure. *Moist*: Quite plastic and usually sticky when wet; stains fingers. (A silty clay feels smooth, a sandy clay feels gritty.) Sand: 0-45%, Silt: 0-40%, Clay: 40-100%.

TRANSPARENCY MASTER #8

Soil Triangle


100% CLAY
PERCENT CLAY
PERCENT SILT
PERCENT SAND
100% SAND
100% SILT
90
80
70
60
50
40
30
20
10
CLAY
SILTY CLAY
SANDY CLAY
CLAY LOAM
SILTY CLAY LOAM
SANDY CLAY LOAM
LOAM
SILT LOAM
SANDY LOAM
LOAMY SAND
SAND
SILT

TRANSPARENCY MASTER #9

Porosity of Soils

General relationship among texture, bulk density, and porosity of soils.

Textural class	Bulk density	Porosity
	g/cc	%
Sand	1.55	42
Sandy loam	1.40	48
Fine sandy loam	1.30	51
Loam	1.20	55
Silt loam	1.15	56
Clay loam	1.10	59
Clay	1.05	60
Aggregated clay	1.00	62

From R. L. Hausenbuiller, *Soil Science: Principles and Practices*, 3d ed. Copyright 1985. Wm. C. Brown Publishers, Dubuque, Iowa. All Rights Reserved. Reprinted by special permission.

TRANSPARENCY MASTER #10

Classification of Soil Structure

The Classification of Soil Structure is Based Largely on Shape

Four General Types of Structures and Their Subtypes

1. Platy
2. Prismlike
    a. Prismatic
    b. Columnar
3. Blocklike
    a. Angular
    b. Subangular Blocky
4. Spheroidal
    a. Granular
    b. Crumb

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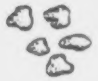
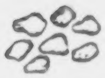
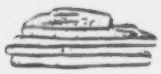
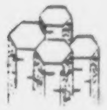
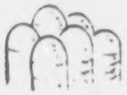
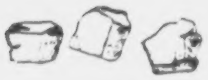
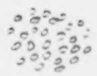
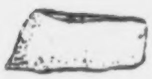
TRANSPARENCY MASTER #11

Soil Structure Diagrams

TYPE	SHAPE
GRANULAR	
CRUMB	
PLATY	
PRISMATIC	
COLUMNAR	
BLOCKY	
SINGLE GRAIN	
MASSIVE	

The generalized relationship between soil structure and the infiltration rate of water into the soil. A soil with a *single grain* or *granular* structure has a rapid rate; a soil with a *blocky* or *prismatic* structure has a moderate rate; and a soil with a *platy* or *massive* structure has a slow rate of infiltration. In rice paddy soils there is conscious effort to create a *platy* or *massive* structure at a depth of approximately 6 inches (15 cm) to reduce the loss of water by percolations. For all *upland* crops, it is desirable to so manage the soil that it has moderate infiltration rate to reduce runoff losses of water and ~~to reduce~~ soil erosion, and to increase water available for plant growth. (Courtesy, USDA)

STUDENT ACTIVITIES

STUDENT WORKSHEET #1 — Classifying Soil Word Search (with solution)

STUDENT WORKSHEET #2 — Factors of Soil Formation

STUDENT WORKSHEET #3 — Classification of Soil Parent Materials

STUDENT WORKSHEET #4 — Soil Color

STUDENT WORKSHEET #5 — Demonstrating Ribbon Test for Soil Texture

STUDENT WORKSHEET #6 — Laboratory Exercise to Determine Soil Texture

STUDENT WORKSHEET #7 — Laboratory Exercise to Determine Soil Drainage

STUDENT WORKSHEET #8 — Soil Classification According to Texture

STUDENT WORKSHEET #9 — Determining Soil Permeability

STUDENT WORKSHEET #10 — Classification of Soil Structure Word Search (with solution)

For additional activities, teachers may refer to the "Suggested Teaching Activities and Procedures" section in the Instructor's Guide.

STUDENT WORKSHEET #1

Classifying Soil Word Search

Y	N	V	U	Y	H	P	A	R	G	O	P	O	T	L	E	S	W	G	X
E	N	K	N	C	H	E	M	I	C	A	L	P	Z	E	O	X	R	J	L
F	O	S	P	H	P	L	I	O	S	P	O	T	B	R	S	D	W	B	U
D	I	O	B	B	U	H	G	U	Q	F	T	J	G	B	O	P	N	Y	R
K	S	I	T	H	M	T	Y	U	W	E	S	A	S	C	I	Q	F	A	B
V	T	L	Z	F	Y	Y	A	S	T	O	N	S	R	B	L	I	X	R	S
Z	V	P	P	W	C	Y	N	T	I	I	M	Q	J	E	S	R	M	O	Q
N	R	R	F	A	G	E	L	L	C	C	Q	V	E	S	T	L	C	C	S
V	H	O	B	E	R	I	T	M	S	Q	A	X	A	F	R	M	Y	O	R
M	K	F	M	C	S	E	A	O	W	J	E	L	X	M	U	T	I	K	E
Y	Q	I	H	F	X	T	N	X	W	L	C	U	N	V	C	L	R	R	Z
G	T	L	M	T	T	C	K	T	Q	X	A	U	X	A	T	K	P	W	J
B	U	E	U	E	D	L	J	Y	M	X	N	C	Y	F	U	I	R	M	T
I	G	R	R	H	W	I	R	M	B	A	L	L	I	U	R	W	K	X	R
G	E	Z	A	E	U	M	V	C	Q	A	T	J	Y	G	E	O	M	O	D
J	I	G	I	U	A	A	N	U	L	D	E	E	W	V	O	D	D	I	J
W	E	Q	J	E	M	T	M	W	Z	A	R	G	R	S	S	L	F	P	V
I	U	D	V	W	U	E	L	Y	I	D	Y	O	P	I	N	N	O	D	X
V	L	S	O	I	L	H	O	R	I	Z	O	N	T	G	A	O	L	I	U
Q	D	I	U	V	B	F	K	L	I	N	M	P	Z	L	L	L	I	W	B

The following words are hidden in the puzzle:

Biological
Chemical
Classify
Clay
Climate
Ions
Organic Matter
Parent Material
Physical
Sand
Silt
Soil
Soil Horizon
Soil Profile
Soil Structure
Soil Texture
Time
Topography
Top Soil

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STUDENT WORKSHEET #1 — Key

Classifying Soil Word Search

•	•	•	•	Y	H	P	A	R	G	O	P	O	T	•	•	•	•	•	•
•	•	•	•	C	H	E	M	I	C	A	L	•	•	•	O	•	•	•	•
•	•	S	•	•	P	L	I	O	S	P	O	T	•	R	S	D	•	•	•
•	•	O	•	•	•	H	•	•	•	•	•	•	G	•	O	•	N	Y	•
•	•	I	•	•	•	•	Y	•	•	•	S	A	•	•	I	•	F	A	•
•	•	L	•	•	•	•	•	S	•	O	N	•	•	•	L	I	•	•	S
•	•	P	P	•	•	•	•	T	I	I	•	•	•	•	S	•	•	•	•
•	•	R	•	A	•	•	L	L	C	C	•	•	•	S	T	•	•	•	S
•	•	O	•	E	R	I	T	M	•	•	A	•	A	•	R	•	•	O	•
•	•	F	M	•	S	E	A	•	•	•	•	L	•	•	U	•	I	•	•
•	•	I	•	•	X	T	N	•	•	L	C	•	•	•	C	L	•	•	•
•	T	L	•	T	T	C	•	T	•	•	A	•	•	•	T	•	•	•	•
•	•	E	U	E	•	L	•	•	M	•	•	C	•	•	U	•	•	•	•
•	•	R	R	•	•	I	•	•	•	A	•	•	I	•	R	•	•	•	•
•	E	•	•	•	•	M	•	C	•	•	T	•	•	G	E	•	•	•	•
•	•	•	•	•	•	A	•	•	L	•	•	E	•	•	O	•	•	•	•
•	•	•	•	•	•	T	•	•	•	A	•	•	R	S	•	L	•	•	•
•	•	•	•	•	•	E	•	•	•	•	Y	•	•	I	N	•	O	•	•
•	•	S	O	I	L	H	O	R	I	Z	O	N	•	•	A	O	•	I	•
•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	L	I	•	B

The following words are hidden in the puzzle:

- Biological
- Chemical
- Classify
- Clay
- Climate
- Ions
- Organic Matter
- Parent Material
- Physical
- Sand
- Silt
- Soil
- Soil Horizon
- Soil Profile
- Soil Structure
- Soil Texture
- Time
- Topography
- Top Soil

STUDENT WORKSHEET #2

Factors of Soil Formation

Agents or conditions that determine the rate, direction, and extent of soil development.

Students should read pages 47-57 in *Soil Science - Principles and Practices* and describe how each of the following agents or conditions determine the rate, direction, and extent of soil development.

1. Parent Material

2. Climate

3. Living Matter

4. Topography

5. Time

STUDENT WORKSHEET #3

Classification of Soil Parent Materials

Answer all questions. (Refer to Information Sheet #4)

1. In the space provided, list two things that can be judged about a parent material from knowledge of its class.

   A.

   B.

2. The greatest part of ____________ accumulates in lake and swamp water.

3. This type of parent material is produced by the movement of materials down a slope under the direct influence of gravity. Name the type of parent material.

4. ______________ occur in three principal forms: slowly sifting, coarse-textured sand dunes; loess; and tephra.

5. The weathering of consolidated rock produces ___________________ .

6. Sediments deposited from _____________ are called alluvium.

7. This type of parent material results from tremendous pressure produced by thick sheets of flowing ice. Name the type of parent material.

8. Materials that have settled from lake water are called _____________ .

9. ______________ accumulate in an ocean environment and are later exposed by natural or artificial means while still in an unconsolidated state.

STUDENT WORKSHEET #4

Soil Color

(Reference for this worksheet is VAS Slidefilm #F708, *Soil Color.*)

1. What gives the surface soil its dark color?

2. What caused the thick, dark surface layer in prairie soils?

3. Why is the surface layer thinner on timber soils?

4. Why are the prairie soils of Southern Illinois lighter than those of Northern Illinois?

5. Why is erosion more hazardous on timber soils than on prairie soils?

6. Other than organic matter, what influences subsoil colors?

7. Why do soils that are poorly drained tend to be dull colored?

8. What colors are found in subsoils that are wet part of the time?

9. What names are used to describe surface soil colors? Subsoil colors?

STUDENT WORKSHEET #5

Demonstrating Ribbon Test for Soil Texture

Purpose:

1. To learn to determine soil texture.

Materials:

1. soil samples of various textural groups (fine, moderately fine, medium, etc.)
2. water for moistening samples, if needed

Procedure:

1. Moisten a sample of soil to the consistency of a workable putty.
2. From this sample, make a ball about 1/2 inch in diamter.
3. Hold the ball between the thumb and forefinger, and gradually press the thumb forward, forming the soil into a ribbon.
4. If a ribbon forms easily, and is long and pliable, the soil is fine textured.
5. If a ribbon forms but breaks into pieces 3/4 to 1 inch long, the soil is moderately fine textured.
6. If no ribbon is formed, and soil feels smooth and talc-like with little grittiness, the soil is medium textured.
7. If no ribbon is formed, and the soil feels very gritty, the soil is moderately coarse textured.
8. If the sample consists almost entirely of gritty material and leaves little or no stain on the hand, it is coarse textured.

Exercise:

1. Have students practice the procedure.
2. Have students identify the textural group of each of the various soil samples.

Questions:

1. Which sample formed the longest ribbon?
2. Which sample had the highest clay content?
3. Which sample felt grittiest?
4. What is the textured class of that sample?
5. Why should soil be moist to do this test?

STUDENT WORKSHEET #6

Laboratory Exercise to Determine Soil Texture

Purpose:

1. To recognize the effect of soil particle size on settling rate.
2. To use a simple laboratory method to determine the texture of a specific soil.
3. To transfer data obtained to a texture triangle and predict soil type.

Materials:

1. various soils
2. water
3. quart jar with lid or sedimentation cylinder
4. metric ruler
5. 2.5 N Sodium Hexametaphosphate
6. 20 ml graduated cylinder

Procedure:

1. Place 1/2 cup (125 ml) of soil in quart jar (sedimentation cylinder).

2. Place 3 1/2 cups (875 ml) of water in with soil.

3. Place 5 tablespoons of Calgon solution (Sodium Hexametaphosphate) in with soil and water.

4. Place lid on container and shake vigorously for five minutes.

5. Allow contents to settle for 24 hours.

6. Use ruler to measue depth of settled soil, record this as total depth.

7. Shake container again for five minutes.

8. Allow contents to settle for 40 seconds.

9. Use ruler to measure depth and record this as sand depth.

10. Allow contents to settle for 30 minutes, measure depth. Difference between this depth and sand depth equals silt depth. Depth (from #10) - sand depth (from #9) = silt depth.

11. The clay depth is yet to be determined. This layer is still in suspension. This layer is found by adding the sand depth to the silt depth and subtracting this sum from the total depth. Total depth (from #6) - [silt depth (from #10) + sand depth (from #9)] = clay depth.

12. To Find Percentages: % Sand = Sand Depth/Total Depth x 100

    % Silt = Silt Depth/Total Depth x 100

    % Clay = Clay Depth/Total Depth x 100

    Use a texture triangle to transfer these figures into a soil type. Note: A soil that contains less than 40% clay is desirable, up to the point of being too sandy.

13. Repeat the procedure for each soil available.

STUDENT WORKSHEET #7

Laboratory Exercise to Determine Soil Drainage

Purpose:

1. To recognize the effect of soil particle size on drainage.
2. To compare the drainage properties of several different soil mixtures.
3. To record observations at specific times.

Materials:

1. soil mixtures
   a. Soil
   b. Sand
   c. Clay
   d. Peat moss
   e. Gravel
2. water columns, with stoppers 12 in (30 cm)
3. spun glass wool
4. graduated cylinders, 100-ml size
5. water
6. ring clamps and stands
7. funnels
8. beakers, 250 ml with 25-ml graduations

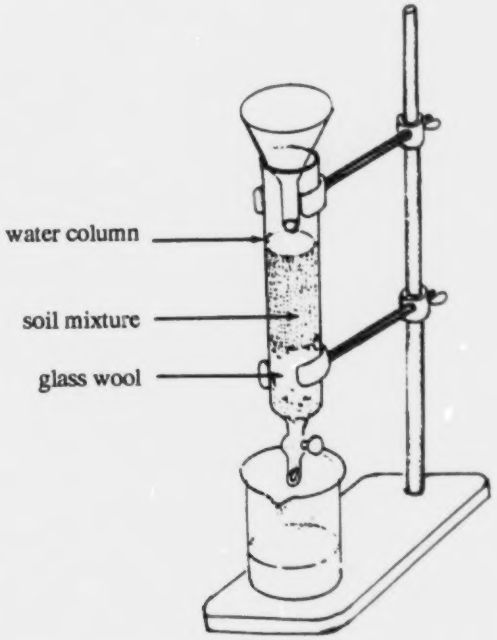

Figure 1. Demonstation Setup.

Procedure:

1. Place a small quantity of glass wool into the water columns and carefully push to the bottom. (The glass wool will hold most of the soil in place.) Be sure the same amount is used in each water column.

2. Place 6 in (15 cm) of soil in each column.

3. Mount the column on the ring stand (see figure 1).

4. Fill each graduated cylinder with 100 ml of water.

5. Position the funnel at the top of each column.

6. Carefully pour the water into the water columns using the funnels. Do not spill any of the water. Record the time the water was added to each column on the data page.

7. Use the data page to record the volume of water collected in the beakers at the prescribed times:
   a. after 5 minutes
   b. after 10 minutes
   c. after 15 minutes
   d. after 1 hour
   e. after 24 hours

Questions:

1. Which mixture permitted the water to flow through the fastest?

2. Which mixture permitted the water to flow through the slowest?

3. Describe the relationship between drainage rate and particle size.

Data page

		Volume of water collected after				
Soil mixture	Starting time	5 min	10 min	15 min	1 hr	24 hr

Adapted from *Horticulture: A Basic Awareness*, by Robert F. Baudendistel.

STUDENT WORKSHEET #8

Soil Classification According to Texture

Match the soil classification in the left column with the correction description(s) in the right column. There will be more than one correct answer for each soil texture classification.

__________ Sandy Soil

__________ Clay Soil

__________ Loam Soil

A. Most desirable soil for plants.
B. Large visible particles.
C. Mixture of organic matter, clay, and sand.
D. Particles invisible to the eye.
E. Particles less that .002 mm in diameter.
F. A rich, fertile soil.
G. Has good drainage.
H. Ability to warm up quickly.
I. Inability to retain water throughout growing area.
J. An enormous capacity to hold water.
K. Inability to prevent the loss of nutrients throughout growing area.
L. Retains sufficient moisture for proper plant growth.
M. An inability to dry out or warm up quickly.
N. Provides plant roots with adequate aeration.
O. Particles 0.1 to 0.5 mm in diameter.

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STUDENT WORKSHEET #8 — Key

Soil Classification According to Texture

Match the soil classification in the left column with the correction description(s) in the right column. There will be more than one correct answer for each soil texture classification.

B,H,I,K,O Sandy Soil

D,E,J,M Clay Soil

A,C,F,G,L,N Loam Soil

A. Most desirable soil for plants.
B. Large visible particles.
C. Mixture of organic matter, clay, and sand.
D. Particles invisible to the eye.
E. Particles less that .002 mm in diameter.
F. A rich, fertile soil.
G. Has good drainage.
H. Ability to warm up quickly.
I. Inability to retain water throughout growing area.
J. An enormous capacity to hold water.
K. Inability to prevent the loss of nutrients throughout growing area.
L. Retains sufficient moisture for proper plant growth.
M. An inability to dry out or warm up quickly.
N. Provides plant roots with adequate aeration.
O. Particles 0.1 to 0.5 mm in diameter.

STUDENT WORKSHEET #9

Determining Soil Permeability

Introduction:

Permeability refers to the rate of water movement through the soil profile. Soil permeability is measured in inches per hour and can be classified as rapid (more than 6 inches per hour), moderate (2 to 6 inches per hour), and slow (less than 2 inches per hour). A moderate rate of water movement is desirable to enable soils to dry after a rain and for flow of septic-tank effluent through a soil. Rapid permeability may mean a droughty homesite or a potential problem from pollution of water by septic-tank effluent.

Purpose:

1. To determine the permeability of various soils. Students can compare the permeability of peat moss, perlite, and sand as described in the procedure below or they can use soil samples brought from home.

Materials:

1. 3 small plastic pots
2. 3 large cans with plastic lids
3. 3 pieces of cheesecloth
4. 3 rubber bands
5. measuring cup
6. water
7. peat moss
8. perlite
9. sand

Procedure:

1. Cover the bottom half of three plastic pots with cheesecloth and secure tightly with rubber bands. Be sure the holes in the pots are covered with cheesecloth to prevent the soil samples from leaking.

2. Fill one pot with peat moss, one with perlite, and one with sand. Label each pot according to its contents.

3. Cut a hole in the plastic lids of the large cans so that the plastic pots will fit inside. Secure the lids on the cans.

4. Hold each pot above the hole cut in the plastic can lid and pour in 1/2 cup of water. Record the time when the water was poured into each pot and also when the water first begins to drip from the pot.

5. Place each pot securely in the lid of the metal cans allowing the water to drain. After 10 minutes remove the pots and measure the amount of water left in each can.

Observations:

1. How long did it take the water to begin dripping from the pot containing peat moss ________, perlite ________, and sand ________?

2. After 10 minutes, how much water was left in the can with the pot containing peat moss ________, perlite ________, and sand ________?

3. Which soil sample is the most permeable?

4. Which soil sample is the least permeable?

STUDENT WORKSHEET #10

Classification of Soil Structure

L	C	O	A	S	U	Q	H	X	U	P	V	N	G	C	U	N	S
A	Z	E	B	P	H	L	F	E	L	T	E	R	O	V	E	S	Q
P	R	P	S	H	G	O	U	U	Z	I	A	L	P	F	U	P	J
B	B	R	H	E	N	B	Y	K	L	N	U	Z	R	B	B	F	P
W	F	I	O	R	J	M	Y	U	U	M	P	P	A	O	A	I	E
G	L	S	M	O	Q	L	S	L	N	J	Y	N	L	Y	B	A	F
P	U	M	Z	I	F	G	A	A	E	X	G	F	C	A	N	P	E
F	I	L	D	D	F	R	R	M	T	U	J	C	E	O	T	Q	O
F	H	I	G	A	L	T	I	Q	L	J	A	K	S	E	S	Y	C
H	J	K	S	L	T	U	T	A	F	O	I	N	F	C	C	I	D
O	O	E	T	V	E	Y	R	D	L	L	E	O	T	I	I	N	A
E	W	Q	P	V	V	B	D	A	K	Z	R	O	T	X	H	U	N
F	A	T	F	K	L	B	V	C	L	F	O	A	A	D	N	O	O
G	D	G	I	O	M	N	O	T	D	N	M	U	L	D	A	G	S
C	A	T	C	U	C	L	K	V	J	S	G	I	J	U	C	L	X
I	G	K	R	A	B	F	K	L	I	N	W	J	U	V	G	A	U
I	Y	C	E	G	O	U	S	R	B	C	M	W	I	P	M	N	O
E	K	F	B	B	Z	Z	P	P	D	T	A	V	T	K	S	X	A

The following words are hidden in the puzzle:

Angular
Blocklike
Columnar
Crumb
Granular
Platy
Prismatic
Prismlike
Spheroidal
Subangular Blocky

STUDENT WORKSHEET #10 — Key

Classification of Soil Structure Word Search

```
•  •  •  •  S  •  •  •  •  •  •  •  •  G  C  •  •  •
•  •  •  •  P  •  •  •  •  •  •  •  R  O  •  •  S  •
•  •  P  •  H  •  •  •  •  •  •  A  L  •  •  U  •  •
•  •  R  •  E  •  •  •  •  •  N  U  •  •  B  •  •  •
•  •  I  •  R  •  •  •  •  U  M  •  P  A  •  •  •  •
•  •  S  •  O  •  •  •  L  N  •  •  N  L  •  •  •  •
•  •  M  •  I  •  •  A  A  •  •  G  •  •  A  •  •  •
•  •  L  •  D  •  R  R  •  •  U  •  •  E  •  T  •  •
•  •  I  •  A  •  •  •  •  L  •  •  K  •  •  •  Y  •
•  •  K  •  L  •  •  •  A  •  •  I  •  •  •  C  •  •
•  •  E  •  •  •  •  R  •  •  L  •  •  •  I  •  •  •
•  •  •  •  •  •  B  •  •  K  •  R  •  T  •  •  •  •
•  •  •  •  •  L  B  •  C  •  •  •  A  •  •  •  •  •
•  •  •  •  O  M  •  O  •  •  •  M  •  L  •  •  •  •
•  •  •  C  U  •  L  •  •  •  S  •  •  •  U  •  •  •
•  •  K  R  •  B  •  •  •  I  •  •  •  •  •  G  •  •
•  Y  C  •  •  •  •  •  R  •  •  •  •  •  •  •  N  •
•  •  •  •  •  •  •  P  •  •  •  •  •  •  •  •  •  A
```

The following words are hidden in the puzzle:

Angular
Blocklike
Columnar
Crumb
Granular

Platy
Prismatic
Prismlike
Spheroidal
Subangular Blocky

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CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Classifying Plants

RELATED PROBLEM AREA(S):

1. Identifying Basic Principles of Plant Science (Central Core Cluster)
2. Classifying Horticultural Plants (Horticulture Cluster)

PREREQUISITE PROBLEM AREA(S):

1. Identifying Basic Principles of Plant Science (Central Core Cluster)

LEVEL: Preparatory

OCCUPATIONAL TASKS ADDRESSED:

Horticulture Cluster

Duty A: Propagating Plants, Seeds, and Cuttings

1. Label planted specimens

Duty J: Designing/Installing Landscapes

1. Select plants

Agricultural Business and Management Cluster

Duty L: Growing Corn, Soybeans, Small Grains, or Forage Crop

1. Select seed varieties

Duty P: Scouting Fields for Weed, Disease, Insect, or Other Damage

1. Identify weeds

STATE GOALS FOR LEARNING:

In planning the instruction for this problem area, teachers can promote the development of several student learning objectives which are related to the State Goals for Learning in Biological and Physical Sciences. These objectives are listed on the Learning Assessment Plan forms included on the following page(s). Those learning objectives marked with an asterisk (*) are taken from the sample lists provided by the Illinois State Board of Education.

Illinois Agricultural Core Curriculum

Agricultural Education 124 Mumford Hall 1301 W. Gregory Drive University of Illinois Urbana, IL 61801

Director: Dale A. Law, Ed.D.
Principal Investigator: Jerry D. Pepple, Ed.D.
Research Assistant: Randy J. Bernhardt

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Illinois Agricultural Core Curriculum Rev.

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date ______________
☐ Original submission ☐ Revision
Page ____ of ____

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☒ Sciences ☐ Physical Development/Health

(Affix label or complete district information.)
COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐
District Name
City

II. STATE GOAL FOR LEARNING
As a result of their schooling, students will have a working knowledge of the concepts and basic vocabulary of biological, physical, and environmental sciences and their application to life and work in contemporary technological society.

Contact Person: ______________
Title: ______________
Phone: ( )

III. LEARNING OBJECTIVES	IV. ASSESSMENT A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	V. EXPECTATIONS Percent of Students Expected to Achieve Objective
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:					
1. List some ways plants are commonly classified.					
2. Define the word taxon and list eight taxa in order. Start with the most general and end with the most specific.					
3. Explain the difference between a cultivar and a botanical variety.					
4. Explain the scientific name for plants.					
5. List six ways plants differ from animals.					
6. Indicate whether a plant is a monocot or a dicot.					
7. Identify by visual inspection the common crop seeds as discussed in class using slides and/or seed samples.					
8. Identify common weed seeds in class by visual inspection of a slide or seed sample.					
9. Classify weed seeds as common, seminoxious, or primary noxious in Illinois.					
*10. Identify a scheme to classify living organisms.					
*11. Understand classification schemes of living organisms.					
*12. Compare living organisms by applying a classification scheme.					

Classifying Plants

Agricultural Business and Management
Plant and Soil Science

ISBE 41-78 (1/88)

Submission Date ____________
☐ Original submission ☐ Revision
Page ____ of ____

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

(Affix label or complete district information.)

COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐

District Name

City

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☒ Sciences ☐ Physical Development/Health

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will have a working knowledge of the processes, techniques, methods, equipment, and available technology of science.

Contact Person: ____________
Title: ____________
Phone: ( )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Use a classification scheme to organize objects.					
878					
					979

ISBE 41-78 (1/88)

Classifying Plants

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Illinois Agricultural Core Curriculum Rev.

Agricultural Business and Management
Plant and Soil Science

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Classifying Plants

STUDENT LEARNING OBJECTIVES:

Upon completion of their study of this problem area, students will be able to:

1. List some ways plants are commonly classified.
2. Define the word taxon. List eight taxa in order, starting with the most general and ending with the most specific.
3. Explain the difference between a cultivar and a botanical variety.
4. Explain the scientific name for plants.
5. List six ways plants differ from animals.
6. Indicate whether a plant is a monocot or a dicot.
7. Identify by visual inspection the common crop seeds as discussed in class using slides and/or seed samples.
8. Identify common weed seeds in class by visual inspection of a slide or seed sample.
9. Classify weed seeds as common, semi-noxious, or primary noxious in Illinois.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Classifying Plants

PROBLEMS AND QUESTIONS FOR STUDY:

1. How can plants be classified by their growth habits?
2. What are the different methods of classifying plants according to flower parts?
3. What type of classification system did Carolus Linnaeus create in 1737 that is still being used today?
4. What does the word taxon mean?
5. What are the eight taxa for classifying? (They must be listed in correct order from most general to most specific.)
6. What is a cultivar?
7. What is a botanical variety?
8. What is the difference between a cultivar and a botanical variety?
9. What is a scientific name?
10. Where does a scientific name come from?
11. What is the purpose of having scientific names for living things?
12. Given common names of plants, what are their scientific names?
13. Can you compare six differences between plants and animals?
14. What is a monocot?
15. What is a dicot?
16. Can you determine if a plant is a monocot or a dicot?
17. How do we identify, by visual inspection, common crop seeds?
18. Can you visually identify common crop seeds?
19. How are common weed seeds identified by visual inspection?
20. Can you visually identify common weed seeds?
21. What are seminoxious weeds?
22. What are primary noxious weeds?
23. Can you classify weeds as common, seminoxious, or primary noxious?
24. Could you be creative and develop your own classification scheme to organize objects?
25. Could you demonstrate the use of your classification scheme?

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Classifying Plants

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES

1. Begin the problem area with an interest approach. Examples:
    a. Write on the board "Why Do We Classify Things?" Have students list the reasons we classify or group things.

    b. Divide students into groups of 3 - 5 people. Provide them with many different sizes, shapes, textures, and colors of stones or other objects. Give each group ten minutes to group items in a manner they choose. Have each group show the other class members how they classified their objects. This exercise should indicate to the students that one can group or classify objects in many different ways. The same is true for plants.

2. Using Information Sheet #1, make sure the class understands terminology necessary for the problem area.

3. Have students complete Student Worksheet #1.

4. Discuss the classification of plants by their growth habits. Refer to Information Sheet #2 and Transparency Master #1. Have students complete Student Worksheet #2.

5. Define "complete flower." Show Transparency Master #2. Using Transparency Master #3 and Information Sheet #3, describe methods of classifying plants according to types of flowers and location of flowers.

6. Discuss other methods of classifying plants. Refer to Information Sheet #4 and Transparency Master #4.

7. Have students complete Student Worksheet #3.

8. Bring in flowers from various plants. Have students carefully dissect them and determine if they are complete, incomplete, etc.

9. Ask students how farmers and agriculturists classify crops. Use Information Sheet #5 and Transparency Master #5. Have students complete Student Worksheet #4 as the class goes through the discussion.

10. Use Transparency Master #6 to show students Carolus Linnaeus' system of taxonomy. This transparency covers the eight taxa for classification (kingdom, division, class, etc.). Transparency Master #7 shows a simplified classification of Roland winter.wheat.

11. Information Sheet #6 may be used for students to identify flowering plants. Distribute copies of the information, supply students with a flower or fruit of a plant that is on this key, and have students identify its correct name.

12. Transparency Master #8 should be used to explain to students where a scientific name comes from and why scientific names are used.

13. Select common crop varieties grown in your area and have students compare the common name with the scientific name. Information Sheet #7 can be copied for student use.

14. Using Student Worksheet #5, have students list the scientific names of plants next to the common names on the worksheet.

15. Conduct a student laboratory experiment on plant identification. VAS Transparency *Forest Tree Identification* (see references) may provide assistance with this laboratory experiment.

16. Compare differences between plants and animals. Refer to Information Sheet #8 and Transparency Master #9.

17. Use Information Sheet #1 to define a monocotyledon and a dicotyledon plant. Use Transparency Master #10 to show and compare monocots and dicots.

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Classifying Plants

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES (Con't.)

18. Have students carefully dissect and label the parts of a bean seed. The seed should be soaked in water overnight to soften it, aiding in easier dissection.

19. Use Information Sheet #9 and Transparency Masters #11 through #15 to identify crop seeds. Have actual samples of crop seeds for students to study and work with.

20. Have students use Student Worksheet #6 to compile a study guide for identification of crop seeds. This same form may be used for a quiz or test.

21. Use Information Sheet #9, Transparency Masters #16 through #33, and actual samples of weeds and weed seeds to identify weed seeds and weed plants. Several VAS filmstrips (see references, item 5) may be of assistance in the identification of weeds and weed seeds.

    F791b — Weed Identification
    F793 — Identification of Weed Seeds
    F800 — Identification of Weed Seedlings, Pt. 1
    F801 — Identification of Weed Seedlings, Pt. 2
    F802-2 — Weed Seedlings and Vegetative Identification
    F811 — The Wicked World of Weeds

22. Use Student Worksheet #7 for students to compile a weed seed/weed plant identification study guide. This same form may be used for a quiz or test.

23. Have students put together a weed collection. Include plants with roots, stems, leaves, and flowers (if possible). Identify each plant by its common name and scientific name.

24. Form a Crop Judging Team to compete in the FFA contest. Encourage students to participate.

25. Provide a copy of Information Sheet #10 to the students. Discuss primary noxious, secondary noxious, and other common weeds of Illinois.

26. For an activity to close the problem area, have students develop their own classification system for some set of objects or things. Either the instructor or the students can choose the group of things to be classified. Have students explain their classification system through a presentation to the class.

INSTRUCTOR'S NOTES AND REFERENCES

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INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Classifying Plants

REFERENCES

1. *Producing Farm Crops*. (1981). Boone, Richer, Wilson. Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050.

2. *Crop Production*. (1984). Delorit, Greub, Ahlgren. 5th edition. Prentice-Hall, Inc., Englewood Cliffs, NJ 07632.

*3. *Plant Science—Growth, Development, and Utilization of Cultivated Plants*. (1981). Hartmann, Flocker, Kofranek. Prentice-Hall, Inc., Englewood Cliffs, NJ 07632.

*4. *Forest Tree Identification* (VAS Transparency #T780). Vocational Agriculture Service, College of Agriculture, University of Illinois, 1401 S. Maryland Drive, Urbana, IL 61801. (217) 333-3871.

*5. *Weed Identification* (VAS Filmstrip #F791B); *Identification of Weed Seeds* (VAS Filmstrip #F793); *Identification of Weed Seedlings, Part 1* (VAS Filmstrip #F800); *Identification of Weed Seedlings, Part 2* (VAS Filmstrip #F801); *Weed Seedlings and Vegetative Identification* (VAS Filmstrip #F802-2); *The Wicked World of Weeds* (VAS Filmstrip #F811). Vocational Agriculture Service, College of Agriculture, University of Illinois, 1401 S. Maryland Drive, Urbana, IL 61801. (217) 333-3871.

*Indicates highly recommended reference

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTIONAL RESOURCES

These resources are intended for use by teachers in planning and teaching the materials for this problem area and may be adapted to fit the teaching method(s) used.

INFORMATION SHEET #1 — Terms to be Defined

INFORMATION SHEET #2 — Classifying Plants by their Growth Habits

INFORMATION SHEET #3 — Methods of Classifying Plants According to Flower Parts

INFORMATION SHEET #4 — Other Methods of Classifying Plants

INFORMATION SHEET #5 — Agricultural Classification

INFORMATION SHEET #6 — A Simplified Key to Identifying Some Seed-Bearing Plants (Spermatophytes)

INFORMATION SHEET #7 — Common and Scientific Names of Plants

INFORMATION SHEET #8 — Differences Between Plants and Animals

INFORMATION SHEET #9 — Grass Identification

INFORMATION SHEET #10 — Illinois Seed Law Listing

TRANSPARENCY MASTER #1 — Classifying Plants by their Growth Habits

TRANSPARENCY MASTER #2 — Complete Flower

TRANSPARENCY MASTER #3 — Methods of Classifying Plants According to Flower Parts

TRANSPARENCY MASTER #4 — Other Methods of Classifying Plants

TRANSPARENCY MASTER #5 — Agricultural Classification

TRANSPARENCY MASTER #6 — Carolus Linnaeus' System of Modern Taxonomy or Classification of Plants (1737)

TRANSPARENCY MASTER #7 — Taxonomy of Roland Winter Wheat

TRANSPARENCY MASTER #8 — Scientific Names: What Are They and Why Do We Use Them?

TRANSPARENCY MASTER #9 — Differences Between Plants and Animals

TRANSPARENCY MASTER #10 — Monocots and Dicots

TRANSPARENCY MASTER #11 — Soft Red Winter Wheat

TRANSPARENCY MASTER #12 — Hard Red Winter Wheat

TRANSPARENCY MASTER #13 — Rye

TRANSPARENCY MASTER #14 — Oat Seed

TRANSPARENCY MASTER #15 — Barley

TRANSPARENCY MASTER #16 — Smooth Bromegrass

TRANSPARENCY MASTER #17 — Tall Fescue

TRANSPARENCY MASTER #18 — Orchard Grass

TRANSPARENCY MASTER #19 — Perennial Ryegrass

TRANSPARENCY MASTER #20 — Red Top

TRANSPARENCY MASTER #21 — Kentucky Bluegrass

TRANSPARENCY MASTER #22 — Canada Thistle

TRANSPARENCY MASTER #23 — White Top

TRANSPARENCY MASTER #24 — Leafy Spurge

TRANSPARENCY MASTER #25 — Russian Knapweed

TRANSPARENCY MASTER #26 — Buckhorn Plantain

TRANSPARENCY MASTER #27 — Curly Dock

TRANSPARENCY MASTER #28 — Dodder

TRANSPARENCY MASTER #29 — Quackgrass

TRANSPARENCY MASTER #30 — Cheatgrass

TRANSPARENCY MASTER #31 — Lamb's-Quarters

TRANSPARENCY MASTER #32 — Pigweed

TRANSPARENCY MASTER #33 — Wild Buckwheat

INFORMATION SHEET #1

Terms to be Defined

Botanical variety — a plant group that occurs in the wild.

Clone — a group of plants originating from a single individual and reproduced by vegetative means, such as cuttings, layers, or grafts.

Complete flowers — flowers made up of four principal parts: (1) sepals, (2) petals, (3) stamens, and (4) a pistil.

Cultivars — plants that are able to be propagated with little or no genetic change in the offspring.

Dicotyledon (Dicot) — a plant having two cotyledons or seed leaves in each of its seeds.

Dioecious ("Two Houses") — having the flowers bearing the stamens and those bearing the pistils produced on separate plants.

Fibrous roots — root systems which are very branched and finely divided; very effective in holding soil in place and preventing erosion on steep slopes.

Incomplete flowers — flowers having one or more of the four principal parts absent; see complete flowers.

Imperfect flowers — flowers that lack either the stamens or the pistil.

Inbred line — a strain or genotype which has been selfed or backcrossed so many times that it is homozygous (breeds true when selfed).

Monocotyledon (Monocot) — a plant having only one seed leaf in each of its seeds.

Monoecious ("One House") — having the flowers bearing only stamens and those bearing only pistils produced in different places on the same plant.

Perfect flowers — flowers having both the stamens and the pistil present.

Primary noxious weeds — seeds of weeds which when established are highly destructive, competitive and/or difficult to control by cultural or chemical practices.

Seminoxious weeds — seeds of weeds which are objectionable in fields, lawns, and gardens of this state, but which can be controlled by cultural or chemical practices.

Scientific name — an identification, using Latin language terms, of a specific living thing according to its taxonomic classification of genus and species.

Taproot — single major root with attached root hairs; penetrates to a greater depth than fibrous roots.

Taxon (plural, taxa) — a taxonomic group of plants of any rank such as family, genus, species, and so forth.

Taxonomy — the science dealing with describing, naming, and classifying plants and animals.

INFORMATION SHEET #2

Classifying Plants by their Growth Habits

Botanists refer to four major groups of plants: (1) annuals, (2) winter annuals, (3) biennials, and (4) perennials.

Annuals — plants which germinate, grow, reproduce, mature, and die within one year. Common examples are corn, oats, barley, spring wheat, rice, and soybeans.

Winter Annuals — plants which start their growth in late summer or fall, become dormant during the winter season, then draw on their reserve food to make an early start the next year. They flower, produce seed, and die during the second year. Common examples are winter wheat, winter barley, winter oats, and rye.

Biennials — plants which grow one year, generally building up energy reserves so that they can flower and bear seed the second year, after which they die. Common example are burdock, sugar beets, and carrots.

Perennials — plants which live more than two years when grown under conditions to which they are adapted. Common examples are alfalfa, Kentucky bluegrass, orchard grass, and smooth bromegrass. Several troublesome weeds are also perennials.

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INFORMATION SHEET #3

Methods of Classifying Plants According to Flower Parts

Types of Flowers

Complete flowers — flowers made up of four principal parts: (1) sepals, (2) petals, (3) stamens, and (4) a pistil.

Incomplete flowers — flowers having one or more of the four principal parts absent; see complete flowers.

Perfect flowers — flowers having both the stamens and the pistil present.

Imperfect flowers — flowers that lack either the stamens or the pistil.

Note: All complete flowers are also perfect flowers. An incomplete flower could be a perfect flower if it is not missing the stamens and the pistil. An incomplete flower is imperfect also if it lacks either the stamens or the pistil.

Location of Flowers

Dioecious ("Two Houses") — having the flowers bearing the stamens (male pollen) and those bearing the pistils (female eggs) produced on separate plants.

Monoecious ("One House") — having flowers bearing only stamens and those bearing only pistils produced in different places on the same plant.

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INFORMATION SHEET #4

Other Methods of Classifying Plants

Root Structure

Fibrous Root Plants — plants having root systems very branched and finely divided; very effective in holding soil in place and preventing erosion on steep slopes.

Taproot Plants — plants having a single major root with attached root hairs; penetrates to a greater depth than fibrous roots.

Seed Leaves

Dicotyledon (Dicot) — a plant having two cotyledons or seed leaves in each of its seeds.

Monocotyledon (Monocot) — a plant having only one seed leaf in each of its seeds.

INFORMATION SHEET #5

Agricultural Classification

It is common for agriculturists to classify plants according to the use made of the crop. Of course, the agriculturalist uses the botanical system as well, adding to it a consideration of crop use.

Cereals or Grain Crops — crops grown for their seed or grain which is to be used for food or feed. Examples are corn, soybeans, wheat, oats, barley, rye, and rice.

Oil Seed Crops — crops grown for the vegetable oil and concentrated protein contained in the seed. Examples are soybeans, peanuts, cottonseed, sunflowers, safflower, and crambe.

Forage and Pasture Crops — crops grown primarily for their leaf or plant parts; usually used for livestock feed. Examples are corn (when used for silage), alfalfa, clovers, lespedeza, and birdsfoot trefoil, plus numerous grasses such as Kentucky bluegrass, smooth bromegrass, orchard grass, tall fescue, and Bermuda grass.

Root and Tuber Crops — plants grown for their underground storage organs, whether these are roots or tubers. Examples are sugar beets, turnips, rutabagas, sweet potatoes, mangels, and carrots.

Fiber Crops — those plants which provide materials for clothing and shelter. Examples are cotton (principal fiber crop in the U.S.) and flax (limited U.S. acreage).

Sugar Crops — sugar beets and sugar cane for sugar production. Sugar beets are a far more important crop than sugar cane in the United States.

Special Crops — crops such as tobacco and hops, which are important in certain sections of the United States. Hops are grown primarily in the Pacific Northwest, while tobacco is grown primarily in the southeastern states.

INFORMATION SHEET #6

A Simplified Key for Identifying Some Seed-Bearing Plants (Spermatophytes)

1. Ovules and seeds borne naked on scales in cones without typical flowers; trees or shrubs, often evergreen. Gymnospermae
    2. Plant foliage palmlike. CYCADACEAE
    2. Plant foliage not palmlike
        3. One seed in a cup-shaped, drupelike fruit. TAXACEAE
        3. Many seeds in a dry woody cone
            4. Leaves alternate and single
            4. Leaves alternate and in clusters; needle-shaped
                5. Cone-scales without bracts with two to nine seeds
                5. Cone-scales in axils of bracts, flattened, with two seeds. PINACEAE
                    6. Cones upright on top of branchlets. *Abies*
                    6. Cones not upright on branchlets. *Pinus*
                        7. Twigs not grooved. White pines or soft pines
                        7. Twigs grooved. Pitch or hard pines

1. Plants with seeds borne in an ovary (base of pistil) with typical flowers; herbs, trees, and shrubs. Angiospermae
    8. Leaves usually parallel veined, flower parts usually in multiples of three. One seed-leaf or cotyledon. Do not form annual rings when increasing in stem girth. Monocotyledonae
        9. Plant with palmlike leaves. PALMAE
            10. Leaves fanlike
            10. Leaves featherlike. Feather and fishtail palms
                11. Lower feathery leaves not spinelike
                11. Lower feathery leaves spinelike, fruit fleshy with long grooved seed. *Phoenix* spp.
                    12. Plant is a tree with shoots at base, trunk about 50 cm (20 in) in diameter. Fruit edible. *Phoenix dactylifera*, date palm
                    12. Plants not as above. Other *Phoenix* spp.
        9. Plants without palmlike leaves
            13. Perianth none or rudimentary
                14. Stems solid. CYPERACEAE
                14. Stems mostly hollow. GRAMINEAE
                    15. Plants woody, bamboolike. Bamboos
                    15. Plants herbaceous, not bamboolike
                        16. Grasses that produce sugar. *Saccarum* spp.
                        16. Grasses that produce little sugar
                            17. Small grains and their kin (rice, wheat, etc.)
                            17. Cornlike plants and their kin
                                18. Plants monoecious. *Zea mays*, corn
                                18. Plants not monoecious. *Sorghum* spp.
            13. Perianth present
                19. Pistils several, not united. APONOGETONACEAE
                19. Pistils one, carples united, ovary and fruit superior. AMARYLLIDACEAE
                    20. Anthers six, stem a fibrous rhizome. *Agapanthus* spp.
                    20. Anthers six, stem a corm or bulb. *Allium* spp.
                        21. Leaves large, usually hollow and cylindrical. Bulb rounded and large. *Allium cepa*, onion
                        21. Leaves large, usually hollow and cylindrical. Bulb slightly thicker than neck. *Allium fistulosum*

8. Leaves usually without parallel venation, two cotyledons. Herbs, trees, and shrubs with stems increasing in thickness with cambium cells, which form annual rings in woody plants. Dicotyledonae
22. Corolla absent or not apparent, calyx present or lacking
22. Corolla present, calyx usually forming two series of calyxlike bracts
23. Petals united
23. Petals separate
24. Ovary inferior or partly so
24. Ovary superior
25. Stamens few, not more than twice as many as petals
25. Stamens numerous, more than twice as many as petals
26. Habit aquatic. NYMPHAECEAE, water lilies
26. Habit terrestrial
27. Pistils more than one, filaments of stamens united into a tube. MALVACEAE
28. Style - branches slender, spreading at maturity, seeds kidney-shaped. *Hibiscus* spp.
28. Styles united, ovary several carpels, calyx deciduous, seed angular. *Gossypium* spp.
29. Staminal column long, anthers compactly arranged on short filaments. *G. Barbadense*, sea-island
29. Staminal column short, anthers loosely arranged and of varying lengths. *G. hirsutum*, upland cotton
27. Pistil more than one, filaments not united into a tube. ROSACEAE
30. Ovaries superior, fruit not a pome
31. Pistils one, leaves simple and entire. *Prunus* spp.
32. Fruit soft and pulpy. *P. armeniaca*, apricot
32. Fruit dry and hard. *P. Mume*, Japanese apricot
31. Pistils two to many, leaves compound (at least basal leaves)
33. Plants woody shrubs. *Rosa* spp.
34. Styles not extended beyond mouth of hip. Stamens about one-half as long as styles. *R. odorata*
34. Styles extend beyond mouth of hip, stamens about as long as styles. *R. multiflora*
33. Plants herbaceous. *Fragaria* spp.
35. Undersides of leaves are bluish white. *F. chiloensis*, wild strawberry
35. Undersides of leaves are green. Other *Fragaria* spp.
30. Ovaries inferior, fruit a pome
36. Fruit with stone cells. *Pyrus* spp., pears
36. Fruit without stone cells. *Malus* spp., apples

Adapted from *Introductory Plant Physiology*, 2nd edition, by G. Ray Noggle and George J. Fritz, (Englewood Cliffs, New Jersey: Prentice Hall, Inc., 1983), 517, by permission of the publisher.

INFORMATION SHEET #7

Common and Scientific Names of Plants

Common Name	Scientific Name
Alfalfa	
Purple flowered	Medicago sativa
Variegated	Medicago falcata media
Yellow flowered	Medicago falcata
Austrian field cress	Rorippa austriaca
Bahiagrass	Paspalum notatum
Barberry	
European	Berberis vulgaris
Japanese	Berberis thunbergii
Barley	
Irregular	Hordeum irregulare
Six-row	Hordeum vulgare
Two-row	Hordeum distichum
Barnyardgrass	Echinochloa crusgalli
Bean	
Kidney	Phaseolus vulgaris
Pinto	Phaeolus spp.
Scarlet Runner	Phaseolus coccineus
Beggar's Tick	Bidens frondosa
Bentgrass	
Colonial	Agrostis tenuis
Creeping	Agrostis palustris
Velvet	Agrostis canina
Bermuda grass	
Common	Cynodon dactylon
African	Cynodon transvaalensis
Magennis	Cynodon x magennisii
Bradley	Cynodon incompletus var. hirsutus
Birdsfoot Trefoil	
Big	Lotus uliginosus or L. major
Broadleaf	Lotus corniculatus
Narrowleaf	Lotus tenuis
Black Medic	Medicago lupulina
Black Nightshade	Solanum nigrum
Bluegrass	
Annual	Poa annua
Canada	Poa compressa
Kentucky	Poa pratensis
Rough	Poa trivialis
Blue Lettuce	Lactuca pulchella
Bracken Fern	Pteridium aquilinum
Bromegrass	
Downy	Bromus tectorum
Smooth	Bromus inermis
Broomcorn	Sorghum bicolor
Buckwheat	
Common	Fagopyrum esculentum
Tartary	Fagopyrum tartaricum
Buffalo grass	Buchloë dactyloides

Common Name	Scientific Name
Burclover	
California	Medicago hispida
Spotted	Medicago arabica
Burdock	Arctium minus
Buttercup	Ranunculus spp.
Buttonclover	Medicago orbicularia
Carpetgrass	
Common	Axonopus affinis
Tropical	Axonopus compressus
Centipedegrass	Eremochloa ophiuroides
Chickweed, Common	Stellaria media
Clover	
Alsike	Trifolium hybridum
Ball	Trifolium nigrescens
Crimson	Trifolium incarnatum
Egyption or berseem	Trifolium alexandrinum
Ladino	Trifolium repens
Large Hop	Trifolium procumbens
Low Hop	Trifolium dubium
Persian	Trifolium resupinatum
Red	Trifolium pratense
Sub	Trifolium subterraneum
White	Trifolium repens
Cocklebur	Xanthium pennsylvanicum
Corn	
Dent	Zea mays indentata
Flint	Zea mays indurata
Flour	Zea mays amylacea
Pod	Zea mays tunicata
Pop	Zea mays everta
Sweet	Zea mays saccharata
Corn Cockle	Agrostemma githago
Cowpea	Vigna sinensis
Cowpea, Catjang	Vigna sinensis var. cylindrica
Crabgrass	Digitaria spp.
Crotalaria	Crotalaria spp.
Crownvetch	Coronilla varia
Cruled Dock	Rumex crispus
Dallis grass	Paspalum dilatatum
Dandelion	Taraxacum officinale
Death Camas	Camassia spp.
Dodder, Field	Cuscuta pentagona
Dogbane	Apocynum cannabinum
Fall Panicum	Panicum dichotomiflorum
False Flax	Camelina spp.
False Indigo	Baptisia spp.

Fescue	
Chewings	Festuca rubra var. commutata
Hard	Festuca ovina var. duriuscula
Meadow	Restuca elatior
Red	Festuca rubra
Sheep	Festuca ovina
Tall	Festuca arundinacea
Field Bindweed	Convolvulus arvensis
Flax	Lilum usitatissimum
Florida Beggarweed	Desmodium tortuosum
Foxtail	
Giant	Setaria faberii
Green	Setaria verdis
Yellow	Setaria lutescens
Gramagrass	
Blue	Bouteloua gracilis
Sideoats	Bouteloua curtipendula
Halogeton	Halogeton glomeratus
Hemlock, Poison	Conium maculatum
Hoary Alyssum	Berteroa incana
Horsebean	Vicia fabia
Horsenettle	Solanum carolinense
Horsetail	Equisetum arvense
Horseweed	Conyza canadensis
Hound's Tongue	Cynoglossum officinale
Jerulsalem Artichoke	Helianthus tuberosus
Jimson Weed	Datura stramonium
Johnson grass	Sorghum halepense
Kudzu	Peuraia thunbergiana
Lamb's quarters	Chenopodium album
Larkspur	Delphinium spp.
Lespedeza	
Common	Lespedeza striata
Korean	Lespedeza stipulaceae
Sericea	Lespedeza cuneata
Loco Weed	Oxytropis lambertii
Lovegrass	
Lehmann	Eragrostis lehmanniana
Sand	Eragrostis trichoides
Weeping	Eragrostis cruvula
Lupine	Lupinus spp.
Mayweed	Anthemis cotula
Milkweed	
Common	Asclepias syriaca
Swamp	Asclepias incarnata
Whorled	Asclepias verticillata
Millet	
Broomcorn	Panicum miliaceum
Browntop	Panicum ramosum
Foxtail	Setaria italica
Japanese	Echinochloa crusgalli frumentacea
Pearl	Pennisetum glaucum
Proso	Panicum miliaceum
Mullein	
Common	Verbascum thapsus
Moth	Verbascum blatteria
Mustard	
Indian	Brassica juncea
Tumbling (Tumble)	Sisymbrium altissimum
Wild	Brassica kaber
Nettle, Tall	Urtica procera
Nutsedge	
Purple	Cyperus rotundus
Yellow	Cyperus esculentus
Oats	
Common	Avena sativa
Hulless /Large Seeded	Avena nuda
Red, Cultivated	Avena byzantina
Wild, Common	Avena fatua
Wild, Red	Avena sterilis
Orchard grass	Dactylis glomerata
Oxeye Daisy	Chrysanthemum leucanthemum
Parsnip	Pastinaca sativa var. sylvestris
Pea	
Field	Pisum arvense
Field, Austrian Winter	Pisum arvense
Garden	Pisum sativum
Pepper	Capsicum frutescens
Peppergrass	Lepidium spp.
Pigweed	Amaranthus spp.
Plantain, Broadleaf	Plantago major
Plantain, Buckhorn	Plantago lanceolata
Poison Hemlock	Conium maculatum
Poison Ivy	Rhus radicans
Poison Oak	Rhus toxicondendron
Poison Sumac	Rhus spp.
Prickly Pear	Opuntia spp.
Puncturevine, Spiny	Tribulus terrestris
Purslane	Portulaca oleracea
Quackgrass	Agropyron repens
Ragweed	
Common	Ambrosia artemisiifolia
Giant	Ambrosia trifida
Ragwort	Senecio spp.
Rape	Brassica napus
Rescuegrass	Bromus catharticus
Roughpea	Lathyrus hirsutus
Russian Pigweed	Axyris amaranthoides
Russian Thistle	Salsola kali var. tenuifolia
Rye	Secale cereale

Ryegrass	
Italian	Lolium multiflorum
Perennial	Lolium perenne
Sandbur	Cenchrus pauciflorus
Sesbania	Sesbania macrocarpa
Shattercane	Sorghum bicolor
Sheep Sorrel	Rumex acetosella
Shepherd's Purse	Capsella bursa-pastoris
Smartweed	Polygonum spp.
Sneezeweed, Common	Helenium autumnale
Sorghum (grain)	Sorghum bicolor
Sourclover	Melilotus indica
Sowthistle	
Annual	Sonchus oleraceous
Perennial	Sonchus arvensis
Soybean	Glycine max
Spanish Needle	Bidens bipinnata
Spurge	
Flowering	Euphorbia corollata
Leafy	Euphorbia esula
Saint Augustine grass	Stenotaphrum secundatum
Saint-John's-wort	Hypericum perforatum
Sudangrass	Sorghum vulgare sudanense
Sunflower	Helianthus annuus
Sweetclover	
White, Common	Melilotus alba
Yellow	Melilotus suaveolens
Yellow, Common	Melilotus officinalis
Tangier Pea	Lathyrus tingitanus
Tansy	Tanacetum vulgare
Thistle	
Bull	Cirsium vulgare
Canada	Cirsium arvense
Ticklegrass (Wild Barley)	Hordeum jubatum
Timothy	Phleum pratense

Vaseygrass	Paspalum urvillei
Velvetbean	Stizolobium spp.
Velvetleaf	Abutilon theophrasti
Vetch	
Common	Vicia sativa
Hairy	Vicia villosa
Water Hemlock	Cicuta maculata
Wheat	
Club	Triticum compactum
Common	Triticum vulgare
Durum	Triticum durum
Emmer	Triticum diccoccum
Polish	Triticum polonicum
Poulard	Triticum turgidum
Spelt	Triticum spelta
Wheatgrass	
Fairway	Agropyron cristatum
Crested	Agropyron desertorum
Western	Agropyron smithii
White Cockle	Lychnis alba
White Snakeroot	Eupatorium rugosum
Wild Buckwheat	Polygonum convolvulus
Wild Carrot	Daucus carota
Wild Garlic	Allium vineale
Wild Onion	Allium canadense
Wild Parsnip	Pastinaca sativa
Wild Rye	
Canada	Elymus canadensis
Wild Snapdragon	Linaria vulgaris
Yarrow	Achillea millefolium
Yellow Goatsbeard	Tragopogon pratensis
Yellow Rocket	Barbarea vulgaris
Zoysiagrass	
Japanese Lawngrass	Zoysia japonica
Manilagrass	Zoysia matrella
Mascarenegrass	Zoysia tenuifolia

Adapted from *Crop Production*, 5th edition, by Delorit, Greub, and Ahlgren, (Englewood Cliffs, New Jersey: Prentice Hall, Inc., 1984), by permission of Allyn & Bacon, Newton, MA.

INFORMATION SHEET #8

Differences Between Plants and Animals

1. Most plants are stationary, while most animals are mobile.
2. Most plants have the green pigment chlorophyll and hence the remarkable ability to use light to synthesize complex sugars and starch molecules from simple inorganic substances. In contrast, animals rely on ready-made food, feeding on plants or animals.
3. The cell walls of plants are rigid and usually made of cellulose. On the other hand, animals lack rigid cell walls and have only flaccid cell membranes.
4. Cellulose is not synthesized by any animal and hence is distinctive of plants.
5. Many plants have unlimited growth, whereas the growth of animals is limited.
6. Many plants have an indefinite number of parts, that is, the number of leaves, stems, buds, and flowers varies from plant to plant within a species. Animals, however, have a definite number of parts (arms, legs, eyes, etc.).

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INFORMATION SHEET #9

Grass Identification

Many of the following features are difficult to see and can be mastered only with considerable practice and observation.

Smooth Bromegrass

The panicle is more open with spikelets long, narrow, and tight usually containing 3 - 6 seeds. The seed is very flat and papery, with a blunt tip, and with a small awn at the apex. The rachilla is large and pubescent.

Tall Fescue

The inflorescence, a panicle, is larger than on red fescue, with tighter spikelets. The seed is boat shaped with a knobbed rachilla and with spines along the veins of the lemma.

Orchard Grass

The spikelet is small and very dense, and develops in tight clusters within the panicle. The seed is curved with fine hairs along the midvein of the lemma, terminating in a short, curved awn. Rachilla is present, but not knobbed. Stems are much flattened, especially at the base.

Perennial Ryegrass

The inflorescence is a spike, with spikelets arranged edgewise (in contrast to flatwise) to the rachis. The second glume is absent or compressed into the rachis, leaving the appearance of only one glume per spikelet. The seed is boat shaped with a wedge-shaped rachilla, and the inner margin of the palea is minutely toothed. Seed is similar in color and size to seed of tall fescue, but the rachilla is not knobbed.

Redtop

The inflorescence is a definite pyramidal, open panicle which turns red with maturity. The glumes completely enclose the florets. The seed is small, narrow, pointed, and with no apparent rachilla. A tuft of fine hairs may be present at the base of the seed.

Kentucky Bluegrass

Panicle is open with lower branches in whorls of five. The spikelet contains many florets and is much flattened, resulting in compressed seeds. Seeds have a thin hood projecting around the upper half of the seed, and webbing, representing sterile florets, may be present at the base.

INFORMATION SHEET #10

Illinois Seed Law Listing

Prohibited (Primary) Noxious Weed Seeds in Illinois

Definition: Seeds of weeds which when established are highly destructive, competitive and/or difficult to control by cultural or chemical practices.

1. Bindweed, field
2. Cress, hoary
3. Johnson grass
4. Knapweed, Russian
5. Sorghum Alum
6. Sowthistle, perennial
7. Spurge, leafy
8. Thistle, Canada

Restricted (Secondary) Noxious Weed Seed in Illinois

Definition: Seeds of weeds which are objectionable in fields, lawns, and gardens of this State, but which can be controlled by cultural or chemical practices.

1. Buckhorn
2. Bullnettle
3. Carrot, wild
4. Daisy, oxeye
5. Dock, curled
6. Dodders
7. Garlic, wild
8. Giant foxtail
9. Mustards
10. Onion, wild
11. Rape, bird
12. Quackgrass

Other Weed Seeds Commonly Found in Illinois

1. Cheat
2. Foxtail, yellow
3. Jimson
4. Lamb's-quarter
5. Morning glory
6. Pepper grass
7. Pigweed
8. Ragweed, common and giant
9. Smartweed
10. Velvetweed
11. Wild buckwheat

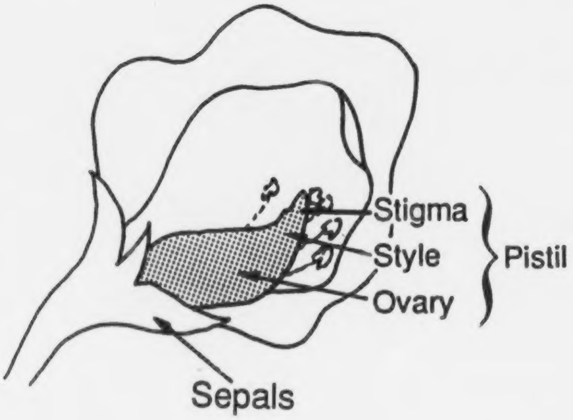
TRANSPARENCY MASTER #1

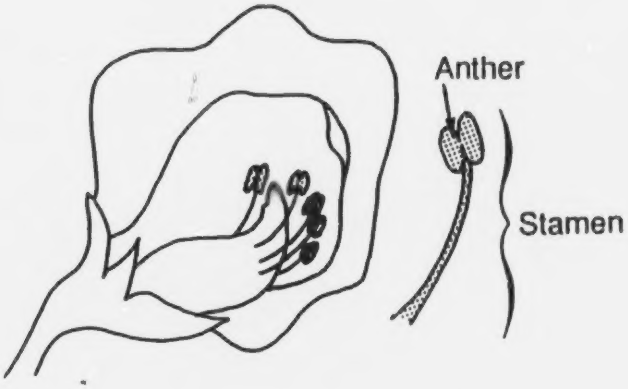
Classifying Plants by their Growth Habits

1. Annuals
2. Winter Annuals
3. Biennials
4. Perennials

TRANSPARENCY MASTER #2

Complete Flower


Stigma
Style
Ovary
Pistil
Sepals


Anther
Stamen

TRANSPARENCY MASTER #3

Methods of Classifying Plants According to Flower Parts

Types of Flowers

1. Complete Flower
2. Incomplete Flower
3. Perfect Flower
4. Imperfect Flower

Locations of Flowers

1. Dioecious
2. Monoecious

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TRANSPARENCY MASTER #4

Other Methods of Classifying Plants

Root Structure

1. Fibrous Root Plants
2. Taproot Plants

Seed Leaves

1. Dicotyledon (Dicot)
2. Monocotyledon (Monocot)

TRANSPARENCY MASTER #5

Agricultural Classification

1. Cereals or Grain Crops
2. Oil Seed Crops
3. Forage and Pasture Crops
4. Root and Tuber Crops
5. Fiber Crops
6. Sugar Crops
7. Special Crops

TRANSPARENCY MASTER #6

Carolus Linnaeus' System of Modern Taxonomy or Classification of Plants (1737)

The Use of Simplified Key to Trace the Identify of an Unknown Plant

	Observation	*Classification*
Kingdom	The organism contains obvious plant attributes. No animal kingdom characteristics are found.	Plant
Division	Distinct flowers and seeds are present.	Spermatophyta
Class	Ovary-borne seeds are found.	Angiospermae
Subclass	Two cotyledons are present, and leaves have net-veining.	Dicotyledonae
Order	Separate flower petals are present as a corolla.	Rosales
Family	Leaves are alternate, sepals and petals occur in four or five, multiple pistils and numerous stamens are present. Habitat is terrestrial.	Rosaceae
Genus	Plant is herbaceous, stemless, and produces runners. Superior ovaries are present.	*Fragaria*
Species	Leaves are bluish white on underside. Thick, sunken achenes are present on receptacle.	*chiloensis* (wild strawberry native to west coast of N. and S. America)

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TRANSPARENCY MASTER #7

Taxonomy of Roland Winter Wheat

Kingdom — Plant

Division — Tracheophyte — vascular system

Subdivision — Angiosperm — seeds enclosed

Family — Gramineae — group of genera

Genus — *Triticum* — group of species

Species — *vulgare* — common wheat

Variety — Roland winter wheat

TRANSPARENCY MASTER #8

Scientific Names: What Are They and Why Do We Use Them?

Scientific Name — each plant has a two-word, or binomial, name. The first name refers to the plant's genus, the second to its species. The scientific name is always in Latin.

What is the Value of Scientific Names?

A most important advantage is that the names are universal and accepted by all nations. Wheat, oats, corn, or any other species may have a wide variety of common names as used in everyday conversation in various parts of the world. But the scientific name is the same and can always be understood, regardless of the location or the language of the people.

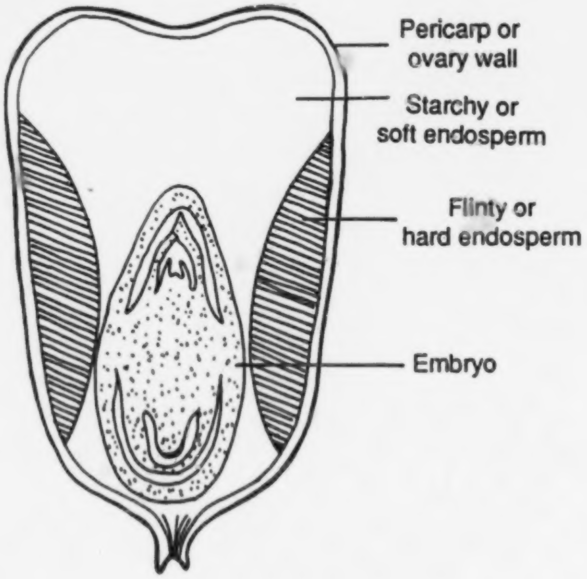
TRANSPARENCY MASTER #9

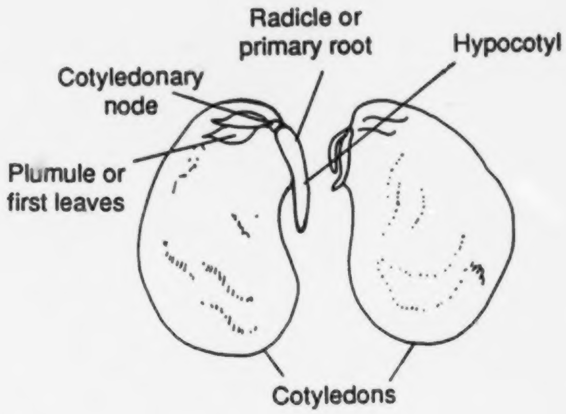
Differences Between Plants and Animals

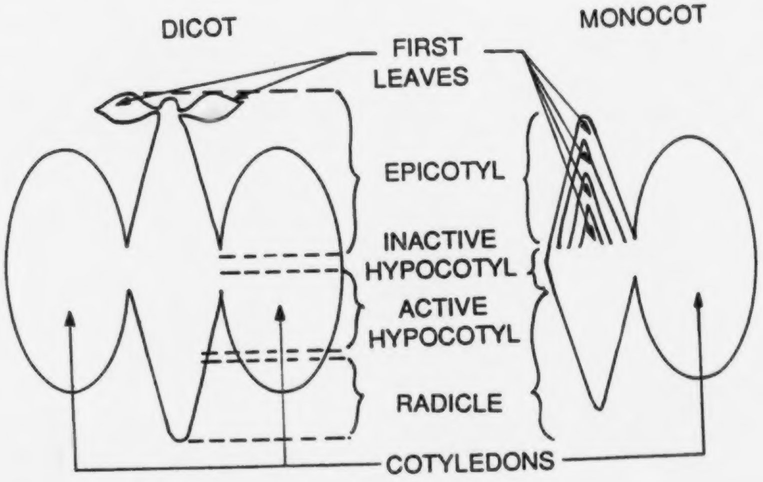
1. Mobility
2. Chlorophyll and Synthesis of Food
3. Cell Walls
4. Synthesis of Cellulose
5. Growth Potential
6. Number of Plant or Animal Parts

TRANSPARENCY MASTER #10

Monocots and Dicots


Pericarp or ovary wall
Starchy or soft endosperm
Flinty or hard endosperm
Embryo

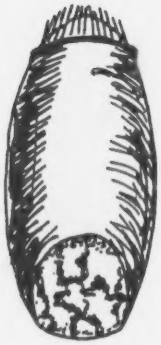

Radicle or primary root
Hypocotyl
Cotyledonary node
Plumule or first leaves
Cotyledons


DICOT
MONOCOT
FIRST LEAVES
EPICOTYL
INACTIVE HYPOCOTYL
ACTIVE HYPOCOTYL
RADICLE
COTYLEDONS

1009

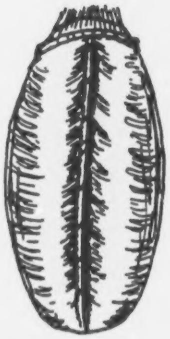
TRANSPARENCY MASTER #11

Soft Red Winter Wheat



BRUSH MIDLONG
DEFINITE RING

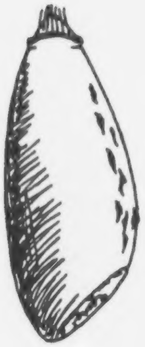
LARGE GERM



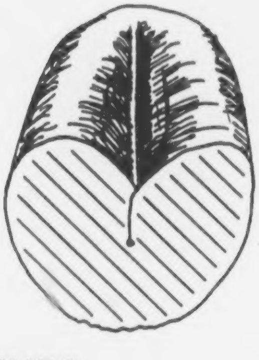
BARREL
SHAPED.
KERNEL

OPEN
CREASE

WIDEST AT
MIDDLE



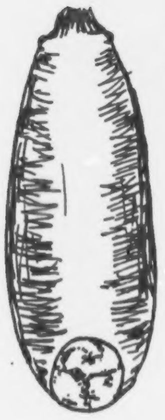
ROUND, SOMETIMES
WRINKLED BACK

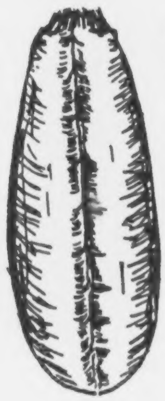


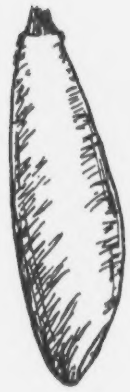
ROUNDED
CHEEKS

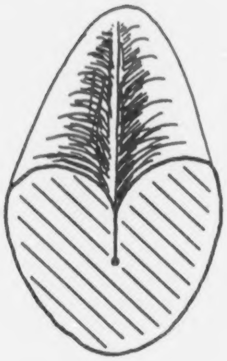
TRANSPARENCY MASTER #12

Hard Red Winter Wheat


BRUSH
MIDLONG
SMALL
GERM


LONG, SLENDER
KERNEL
ROUNDED
CREASE
WIDEST NEAR
GERM END

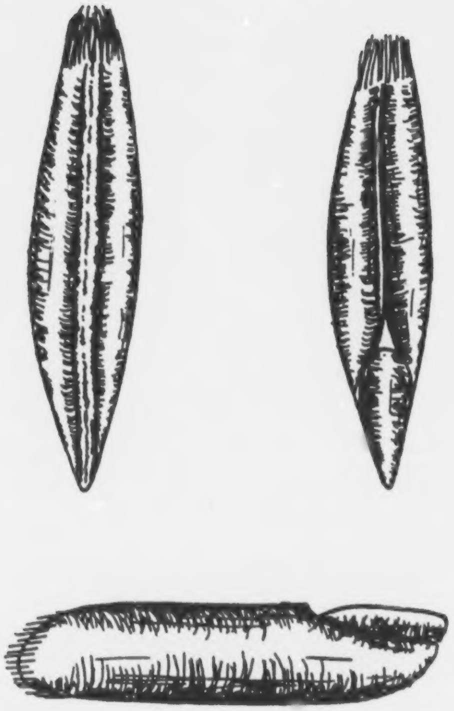

SMOOTH
BACK


ROUNDED
CHEEKS

1011

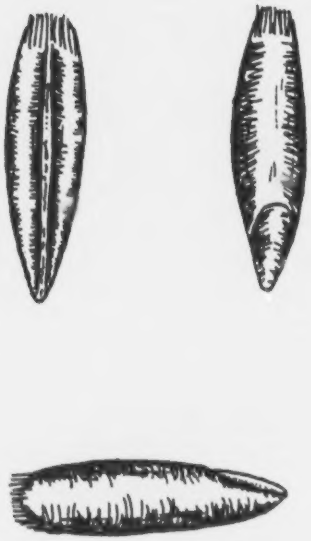
TRANSPARENCY MASTER #13

Rye



TETRA PETCUS

DEEP, OPEN CREASE
LARGE, POINTED GERM
RIDGE ON BACK
SHORT BRUSH

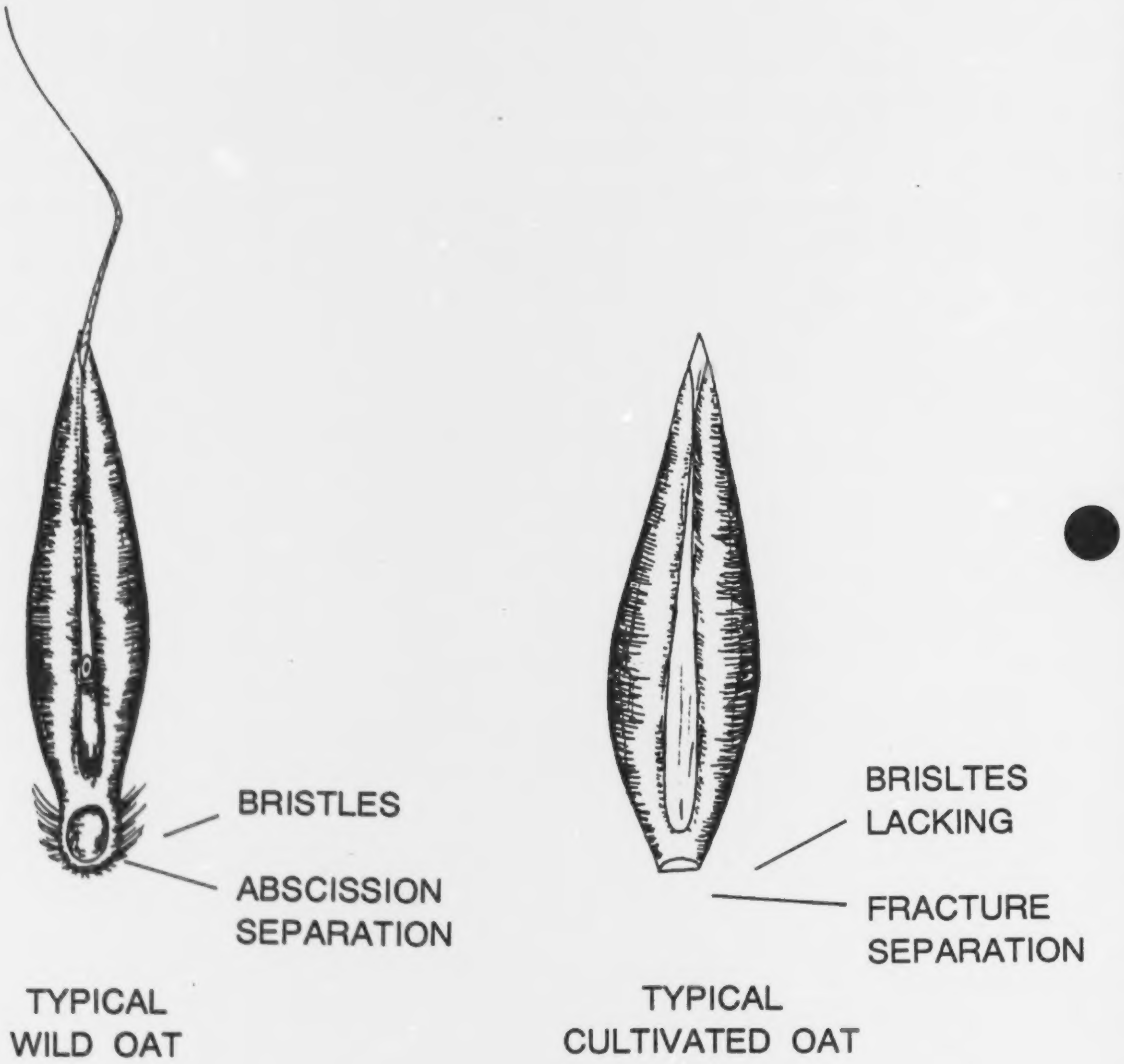


BALBOA

SHALLOW, TIGHT CREASE
LARGE, POINTED GERM
SMOOTH BACK
SHORT BRUSH

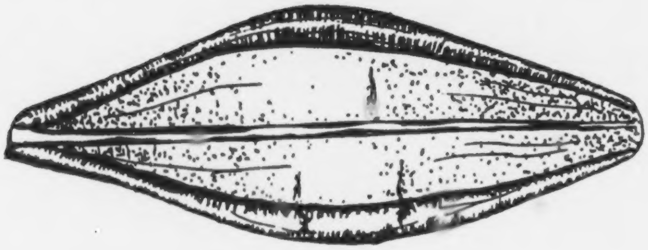
TRANSPARENCY MASTER #14

Oat Seed


BRISTLES
ABSCISSION SEPARATION
TYPICAL WILD OAT
BRISLTES LACKING
FRACTURE SEPARATION
TYPICAL CULTIVATED OAT

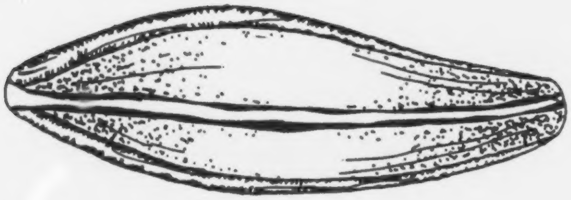
TRANSPARENCY MASTER #15

Barley



2-ROW

ALL KERNELS ARE STRAIGHT

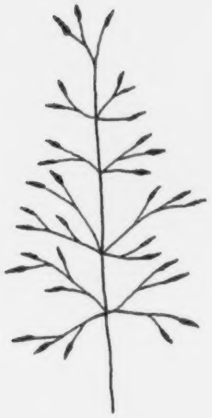


6-ROW

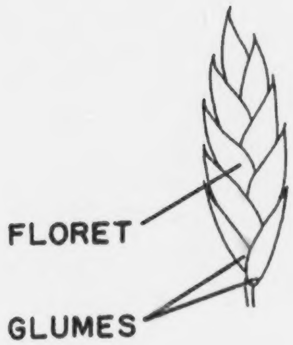
2/3 OF THE KERNELS ARE BENT DUE TO CROWDING AT RACHIS JOINT

TRANSPARENCY MASTER #16

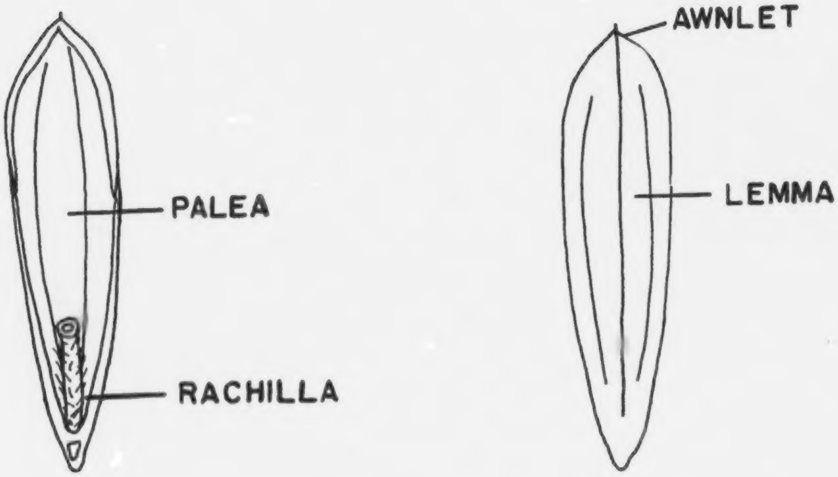
Smooth Bromegrass



INFLORESCENCE


FLORET
GLUMES

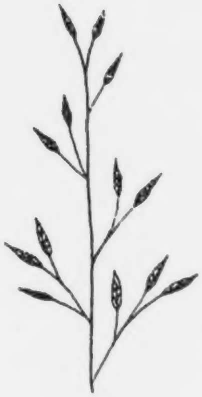
SPIKELET


PALEA
RACHILLA
AWNLET
LEMMA

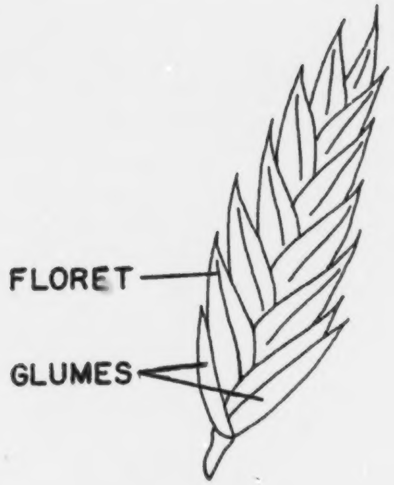
SEED

TRANSPARENCY MASTER #17

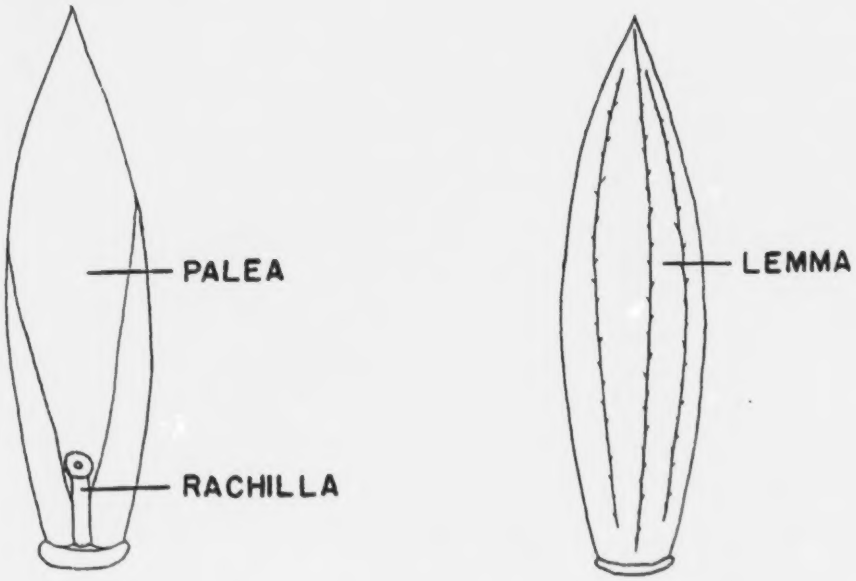
Tall Fescue



INFLORESCENCE


FLORET
GLUMES

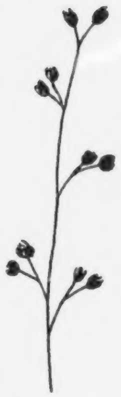
SPIKELET


PALEA
RACHILLA
LEMMA

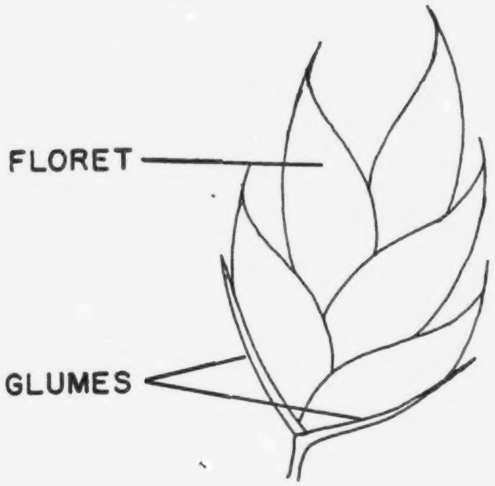
SEED

TRANSPARENCY MASTER #18

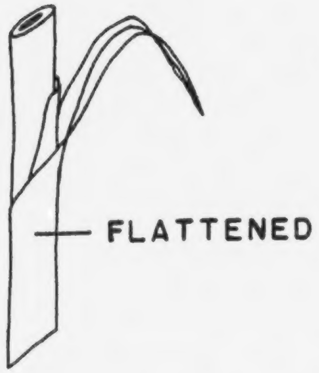
Orchard Grass



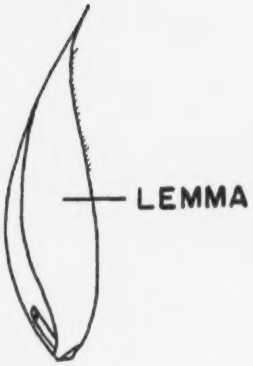
INFLORESCENCE

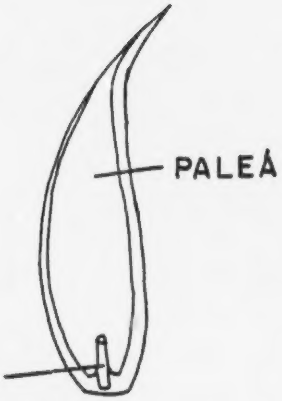

FLORET
GLUMES

SPIKELET



STEM

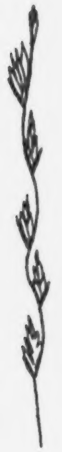



PALEA
RACHILLA

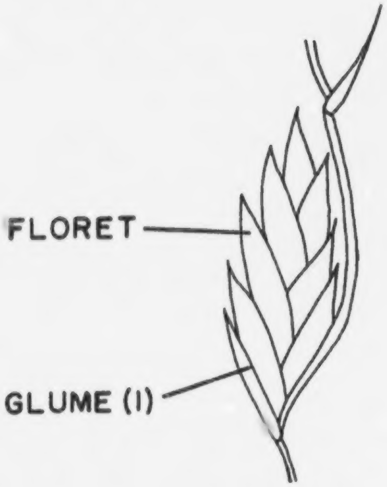
SEED

TRANSPARENCY MASTER #19

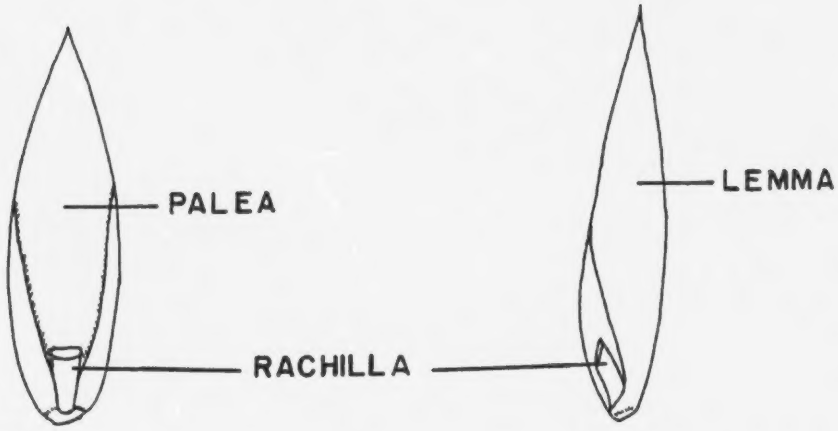
Perennial Ryegrass



INFLORESCENCE


FLORET
GLUME (I)

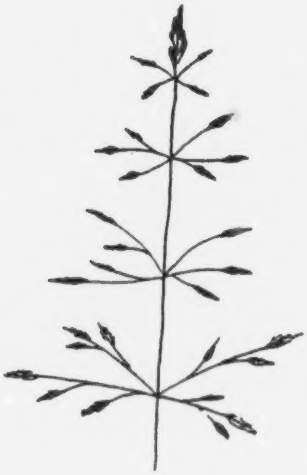
SPIKELET


PALEA
LEMMA
RACHILLA

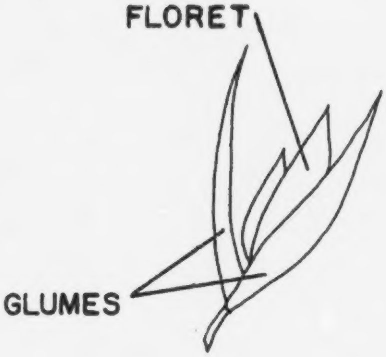
SEED

TRANSPARENCY MASTER #20

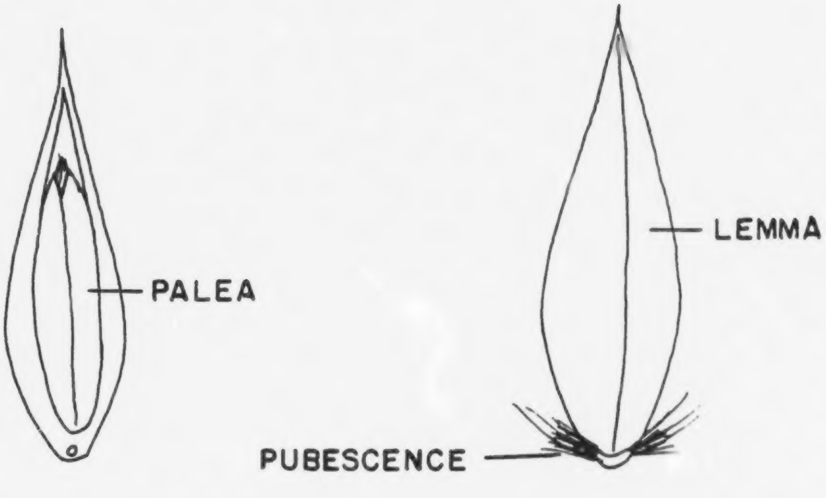
Red Top



INFLORESCENCE


FLORET
GLUMES

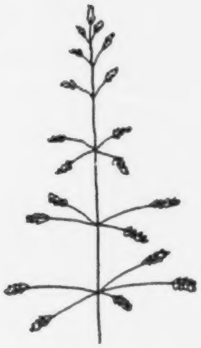
SPIKELET


PALEA
LEMMA
PUBESCENCE

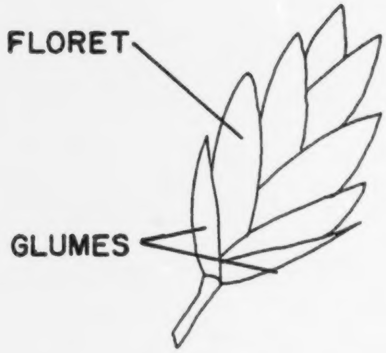
SEED

TRANSPARENCY MASTER #21

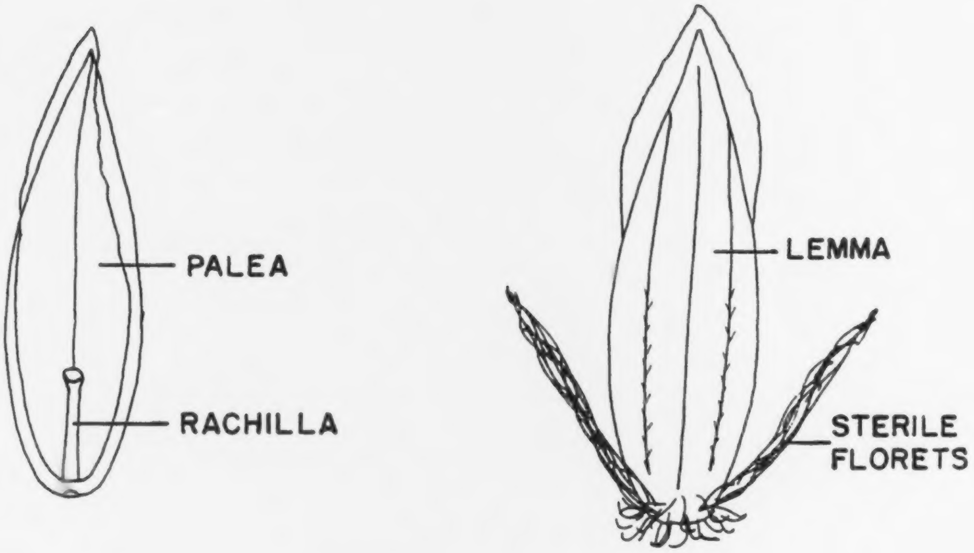
Kentucky Bluegrass



INFLORESCENCE


FLORET
GLUMES

SPIKELET

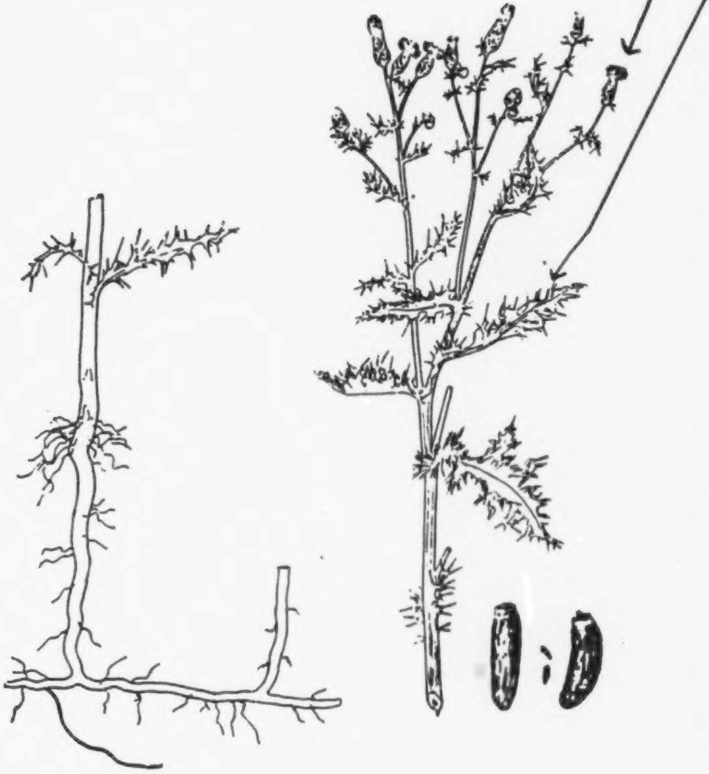

PALEA
RACHILLA
LEMMA
STERILE FLORETS

SEED

TRANSPARENCY MASTER #22

Canada Thistle

Cirsium arvense (L.) Scop
Cursed thistle, Devil's thistle



Rose-purple flowers

Leaves irregular, deeply cut relatively smooth to spiny margins

Both male and female flowers

Plant erect branching near the top

Grows 2 to 7 feet high

Reproduces by seed and by underground rootstocks

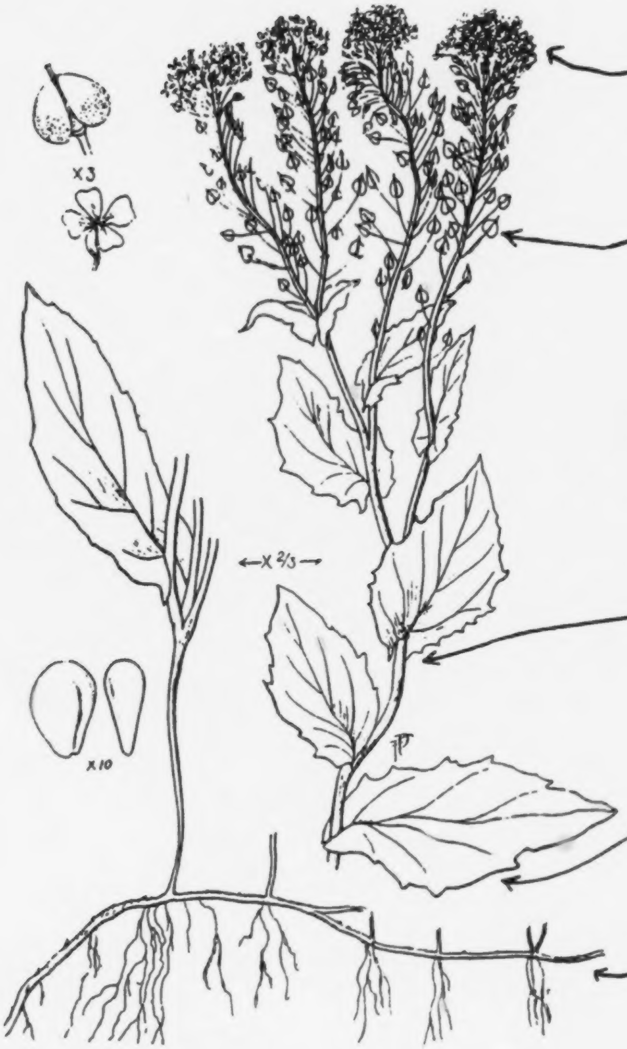
Perennial

1021

TRANSPARENCY MASTER #23

White Top

Cardaria draba
Hoarycress, Perennial peppergrass



Creamy white flowers

Seed pods flattened and heart-shaped

Upper stem branches profusely

Upper leaves clasp the stems

Leaves greyish green

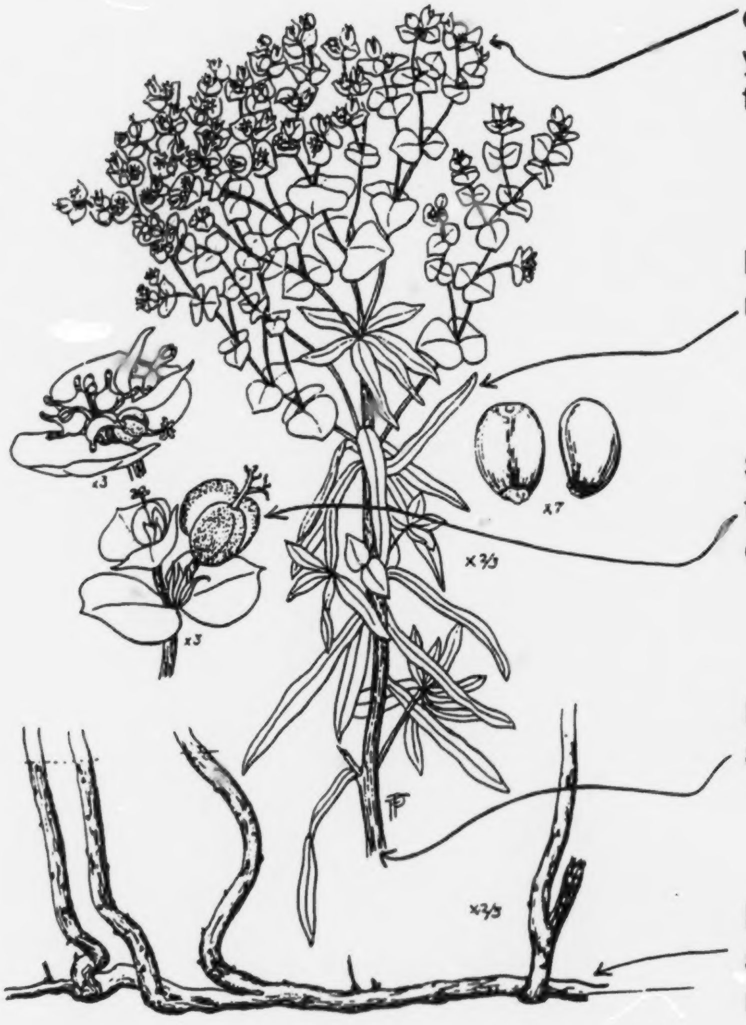
Reproduces by seed and rootstocks

Perennial

TRANSPARENCY MASTER #24

Leafy Spurge

Euphorbia esula (L.) Hill



Entire top portion of plant may appear yellowish green at this stage

Leaves alternate, narrow, and lacelike

Seeds borne in a three-lobed capsule

Entire plant has a milky juice

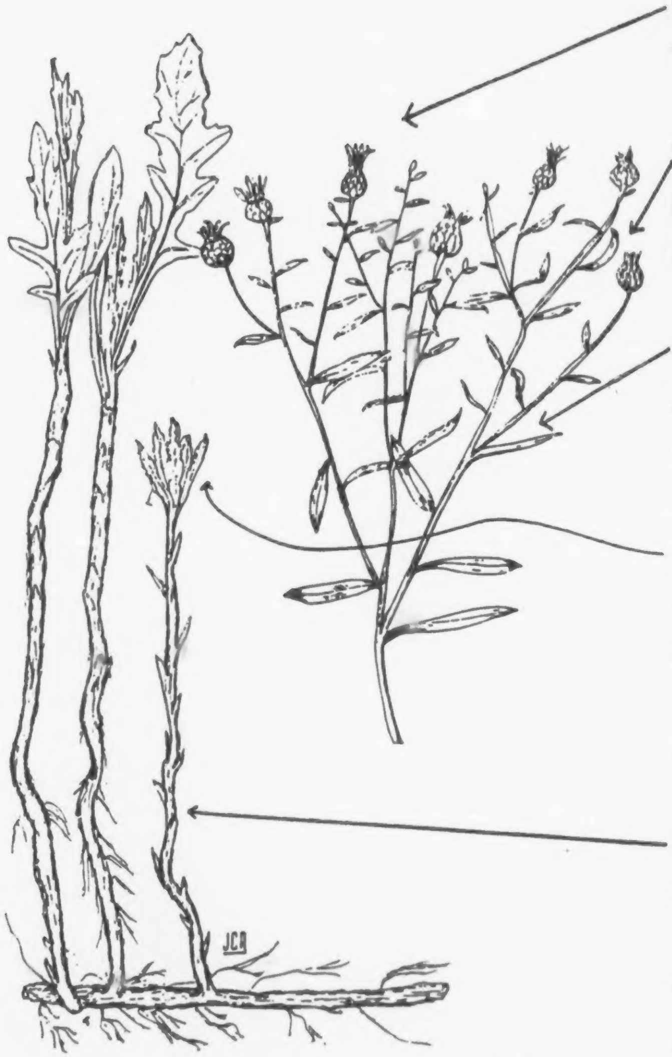
Reproduces by seed and underground rootstalks

Perennial

TRANSPARENCY MASTER #25

Russian Knapweed

Centaurea repens Pall.



Light purple flowers

Seed heads scaly and do not open up at maturity

Upper leaves simple, small and linear

Lower leaves larger and deep notched and covered with downy white hairs

Roots are usually dark brown or black

Entire plant has a lingering bitter taste

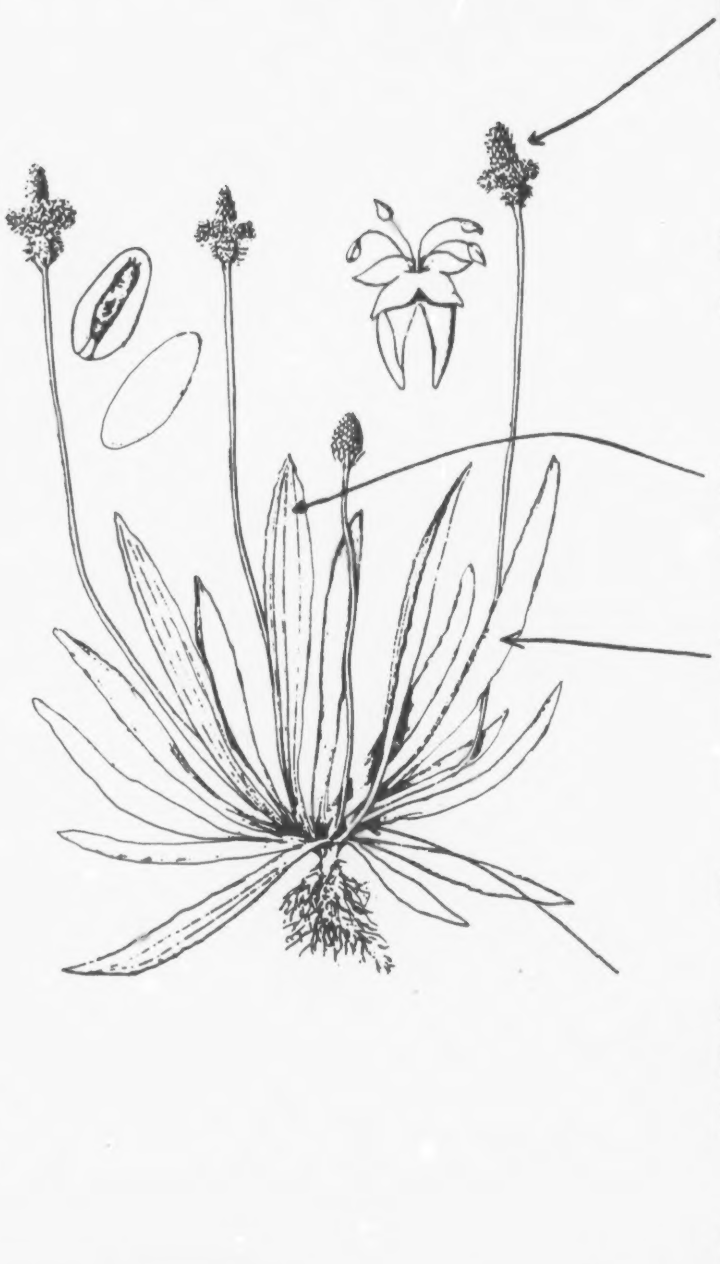
Reproduces by seeds and rootstocks

Perennial

TRANSPARENCY MASTER #26

Buckhorn Plantain

Plantago lancelolata
Buckhorn, Ribgrass



Resembles timothy head

Seed brown, canoe-shaped

3 to 5 prominent veins

Long, narrow lance-shaped leaves

Basal leaves

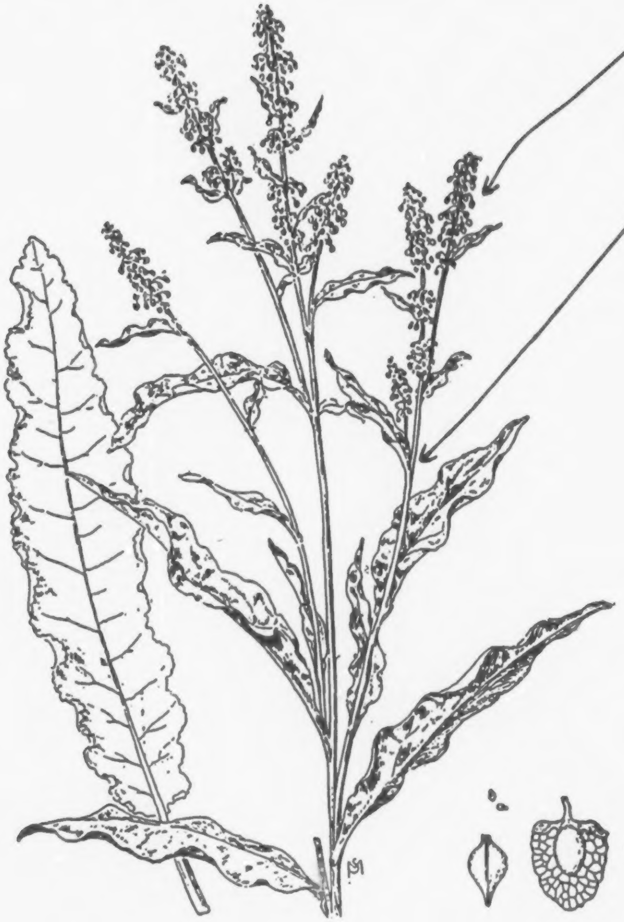
A tuft of brown hairs are at the base of each leaf

Perennial

TRANSPARENCY MASTER #27

Curly Dock

Rumex crispus (L.)
Curled dock, Indian tobacco, Sour dock



Flowers form a triple-winged pod

Reddish brown at maturity

Upper leaves clasping and less wavy than the lower leaves

Lower leaves 6 to 8 inches long and wavy

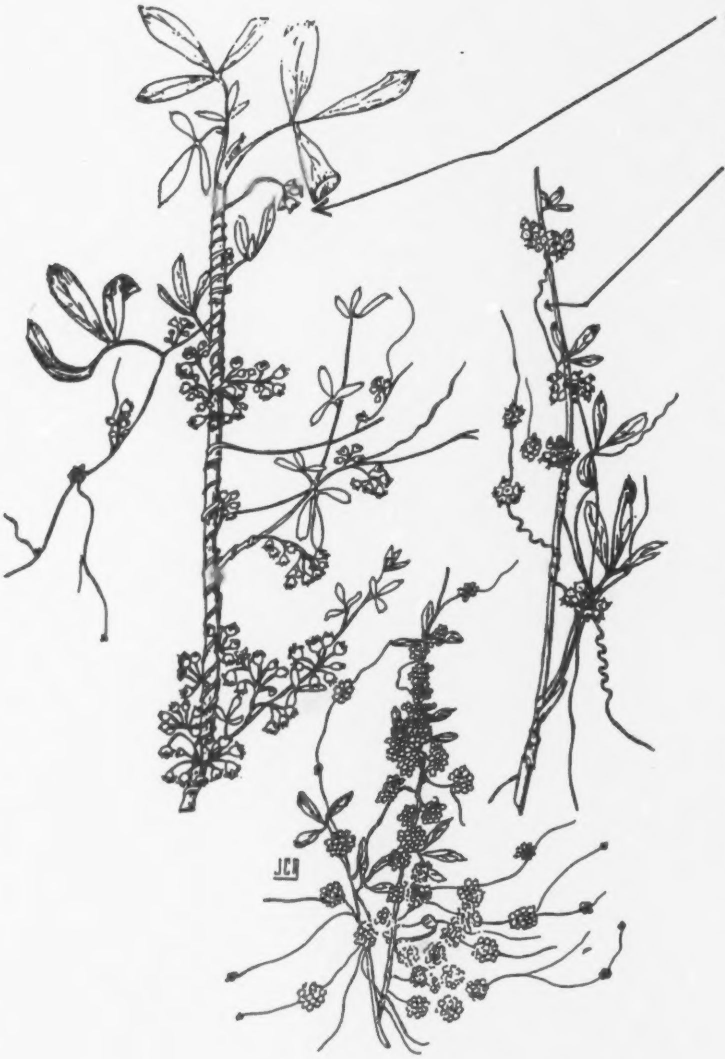
Reproduces by seed

Perennial having a deep taproot

TRANSPARENCY MASTER #28

Dodder

Cuscuta sp.
Devil's hair, Field dodder



Small whitish flowers

Stems hair-like yellow to reddish

No leaves

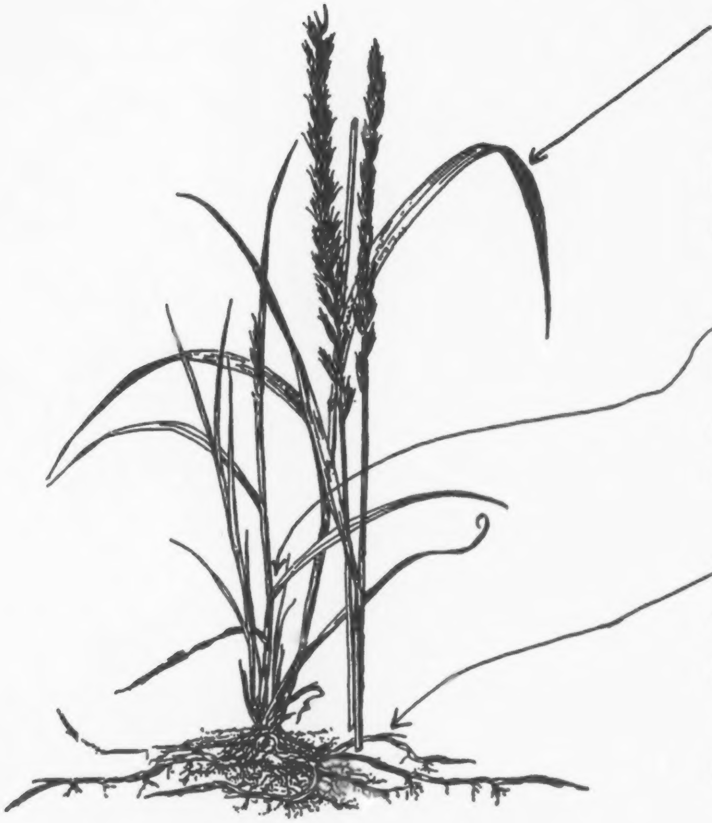
Yellowish seed remains viable five years or more

Plant is parasitic, ground stem soon breaks off

TRANSPARENCY MASTER #29

Quackgrass

Agropyron repens (L.) Beauv.
Couch grass, Devil's grass



Inconspicuous flowers

Grows 1 to 4 feet tall

Leaves are somewhat rough

Lower leaf sheaths are somewhat hairy

At base of each leaf a small pair of claws (auricles) clasp the stem

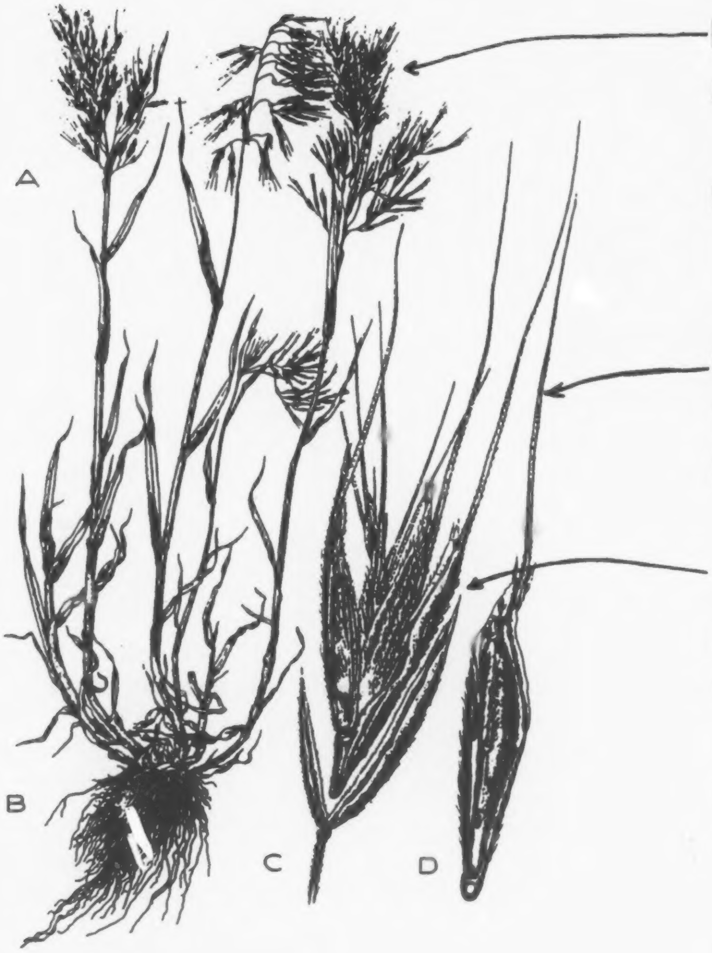
Forms dense mat of white to straw-colored rootstocks

Perennial

TRANSPARENCY MASTER #30

Cheatgrass

Bromus tectorum (L.)



Head loose and nodding

Grows 6 to 24 inches tall

Seeds contain a long rough awn or beard

Turns reddish purple upon maturing

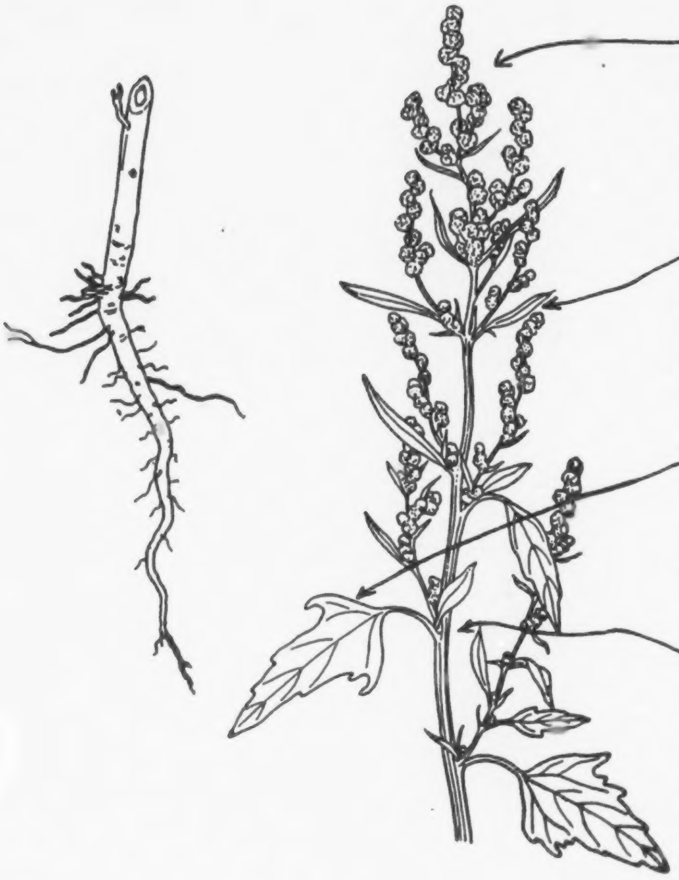
Leaves covered with soft hairs

Annual

TRANSPARENCY MASTER #31

Lamb's-Quarters

Chenopodium album (L.)
Pigweed



Flowers in clusters, green and inconspicuous

Leaves covered with white mealy substance

Leaves have irregular-toothed margins

Stems smooth, often striped with pink or purple and are usually ridged and grooved

Plant grows from 1 to 6 feet high

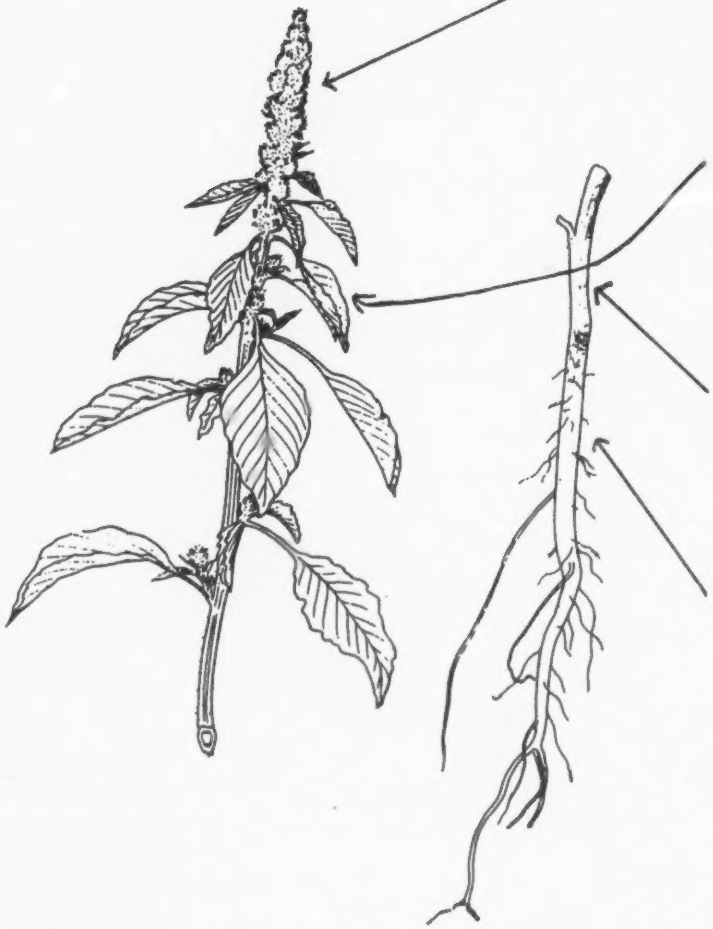
Reproduces by seed

Annual

TRANSPARENCY MASTER #32

Pigweed

Amaranthus retroflexus (L.)
Redroot



Dense prickly clusters of inconspicuous flowers

Leaves somewhat egg-shaped, attached to stem with a long petiole

Rough, somewhat hairy central stem

Reddish pink root

Reproduces by seed

Annual

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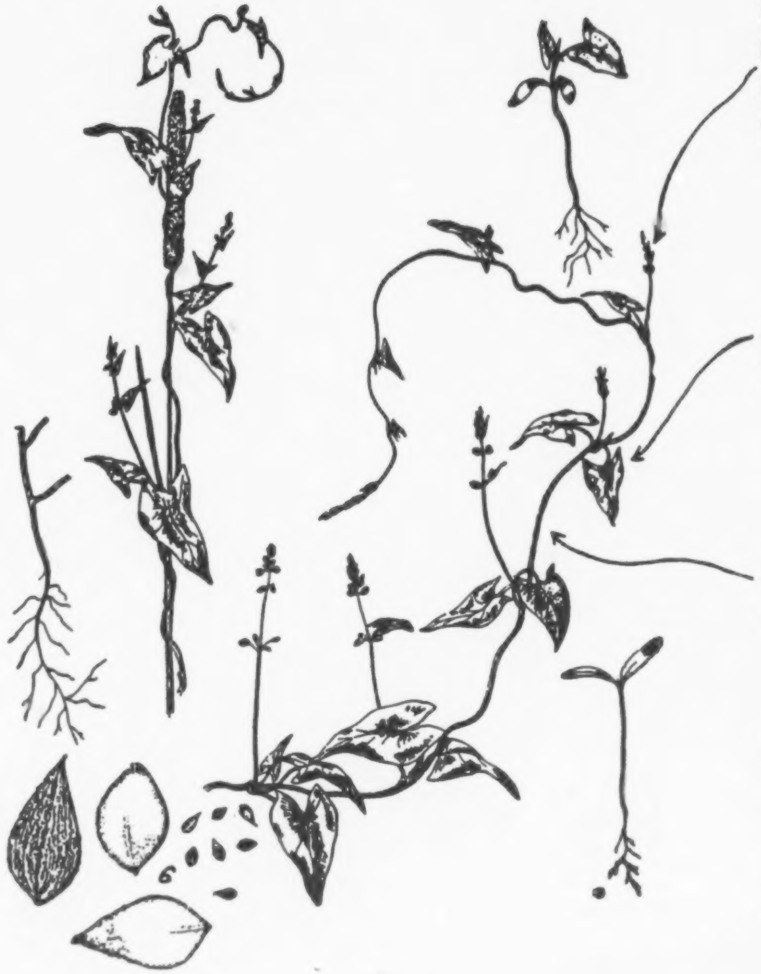
TRANSPARENCY MASTER #33

Wild Buckwheat

Polygonum convolvulus
Black bindweed



Flower inconspicuous, borne in clusters on flower stalks

Leaves arrow- or heart-shaped

Stems long, twining or trailing

Reproduces by seed

Annual

STUDENT ACTIVITIES

STUDENT WORKSHEET #1 — Classifying Plants Word Search (with solution)

STUDENT WORKSHEET #2 — Classifying Plants by their Growth Habits

STUDENT WORKSHEET #3 — Classify Plants According to Flower Parts, Types of Flowers, and Other Methods

STUDENT WORKSHEET #4 — Agricultural Classification

STUDENT WORKSHEET #5 — Common and Scientific Names of Plants

STUDENT WORKSHEET #6 — Identification of Crop Seeds

STUDENT WORKSHEET #7 — Identification of Weed Seeds

For additional activities, teachers may refer to the "Suggested Teaching Activities and Procedures" section in the Instructor's Guide.

STUDENT WORKSHEET #1

Classifying Plants Word Search

K	G	A	E	Y	C	E	F	O	S	L	Q	F	I	W	P	T	I	U	W
A	L	U	Q	N	M	N	N	R	F	E	M	H	I	K	M	M	N	E	P
S	A	A	N	S	C	O	O	I	G	I	S	I	H	H	P	S	C	Y	L
R	W	J	I	Z	E	E	N	X	L	J	M	F	A	E	T	U	O	N	S
E	R	S	R	B	L	M	N	O	A	D	Z	H	R	K	S	O	D	O	T
W	H	S	C	E	O	B	I	O	X	T	E	F	A	K	Y	I	B	D	O
O	Q	I	R	I	W	T	K	N	L	A	E	R	J	R	J	X	Y	E	O
L	Z	S	Y	E	E	O	A	G	O	C	T	B	B	K	H	O	N	L	R
F	Y	G	U	F	W	N	L	N	T	X	D	U	V	N	U	N	D	Y	P
E	B	G	C	T	I	O	T	F	I	U	I	Q	J	Z	I	Y	K	T	A
T	D	D	V	M	N	B	L	I	E	C	C	O	R	K	I	R	F	O	T
E	R	N	Z	N	O	O	R	F	F	T	A	H	U	L	G	A	W	C	Z
L	N	X	L	V	W	N	W	O	T	I	E	L	J	S	T	M	E	O	W
P	A	O	Q	E	C	Z	O	F	U	C	C	L	V	N	P	I	E	N	L
M	A	Q	R	U	J	B	M	E	R	S	E	N	P	A	R	R	D	O	E
O	A	S	Q	O	U	N	B	P	C	Z	R	F	A	M	R	P	S	M	N
C	N	O	D	E	L	Y	T	O	C	I	D	O	R	M	O	I	U	K	O
X	D	I	O	E	C	I	O	U	S	K	O	N	O	E	E	C	E	U	O
R	L	C	V	S	X	Y	Q	B	O	J	T	U	Y	T	P	Q	N	T	G
A	Z	R	A	V	I	T	L	U	C	H	C	E	S	F	S	Q	I	I	Y

The following word are hidden in the puzzle:

Botanical Variety
Clone
Complete Flowers
Cultivar
Dicotyledon
Dioecious
Fibrous Roots
Imperfect Flowers
Inbredline
Incomplete Flowers
Monocotyledon
Monoecious
Perfect Flowers
Primary Noxious
Scientific Name
Seminoxious
Taproots
Taxon
Taxonomy
Weeds

STUDENT WORKSHEET #1 — Key

Classifying Plants Word Search

•	•	•	•	Y	•	E	•	•	•	•	•	•	•	•	•	•	I	•	•
•	•	•	•	•	M	N	N	•	•	•	•	•	•	•	•	M	•	•	•
S	•	•	•	S	•	O	O	I	•	•	•	•	•	•	P	S	•	•	•
R	•	•	•	•	E	E	N	X	L	•	•	•	•	E	•	U	•	N	S
E	•	S	R	B	•	M	N	O	A	D	•	•	R	•	•	O	•	O	T
W	•	S	C	E	O	•	I	O	X	T	E	F	•	•	•	I	•	D	O
O	•	•	R	I	W	T	•	N	L	A	E	R	•	•	•	X	•	E	O
L	•	•	•	E	E	O	A	•	O	C	T	•	B	•	•	O	•	L	R
F	•	•	•	F	W	N	L	N	T	X	•	•	•	N	•	N	•	Y	P
E	•	•	•	•	I	O	T	F	I	•	I	•	•	•	I	Y	•	T	A
T	•	•	•	M	•	B	L	I	E	C	•	O	•	•	•	R	•	O	T
E	•	•	•	•	O	O	R	F	F	T	A	•	U	•	•	A	W	C	•
L	•	•	•	•	W	N	•	O	T	I	E	L	•	S	•	M	E	O	•
P	•	•	•	E	•	•	O	•	U	C	C	L	V	•	•	I	E	N	•
M	•	•	R	•	•	•	•	E	•	S	E	N	P	A	•	R	D	O	•
O	•	S	•	•	•	•	•	•	C	•	R	F	A	M	R	P	S	M	•
C	N	O	D	E	L	Y	T	O	C	I	D	O	R	M	O	I	•	•	•
•	D	I	O	E	C	I	O	U	S	•	O	•	O	E	E	C	E	•	•
•	•	•	•	•	•	•	•	•	•	•	•	U	•	T	P	•	N	T	•
•	•	R	A	V	I	T	L	U	C	•	•	•	S	•	S	•	•	I	Y

The following word are hidden in the puzzle:

Botanical Variety
Clone
Complete Flowers
Cultivar
Dicotyledon
Dioecious
Fibrous Roots
Imperfect Flowers
Inbredline
Incomplete Flowers

Monocotyledon
Monoecious
Perfect Flowers
Primary Noxious
Scientific Name
Seminoxious
Taproots
Taxon
Taxonomy
Weeds

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STUDENT WORKSHEET #2

Classifying Plants by their Growth Habits

Match the plant listed in the right column with its correct classification of growth habit in the left column.

1. ________ Annual

2. ________ Winter Annual

3. ________ Biennial

4. ________ Perennial

A. Winter Wheat
B. Sugar Beets
C. Alfalfa
D. Corn
E. Orchard Grass
F. Barley
G. Burdock
H. Spring Wheat
I. Smooth Bromegrass
J. Winter Oats
K. Winter Rye
L. Soybeans
M. Kentucky Bluegrass
N. Rice
O. Winter Barley
P. Oats

STUDENT WORKSHEET #2 — Key

Classifying Plants by their Growth Habits

Match the plant listed in the right column with its correct classification of growth habit in the left column.

1. *D,F,H,L,N,P* Annual
2. *A,J,K,O* Winter Annual
3. *B,G* Biennial
4. *C,E,I,M* Perennial

A. Winter Wheat
B. Sugar Beets
C. Alfalfa
D. Corn
E. Orchard Grass
F. Barley
G. Burdock
H. Spring Wheat
I. Smooth Bromegrass
J. Winter Oats
K. Winter Rye
L. Soybeans
M. Kentucky Bluegrass
N. Rice
O. Winter Barley
P. Oats

STUDENT WORKSHEET #3

Classify Plants According to Flower Parts, Types of Flowers, and Other Methods

Fill in the blanks with the most appropriate answer.

1. Flowers that lack either the stamens or the pistil are called ________________ flowers.
2. ______________ plants have flowers on "one house."
3. ______________ root systems are very branched and finely divided.
4. A plant having only one seed leaf in each of its seeds is considered a ______________ .
5. ______________ root systems have one major root.
6. A plant is classified as ________________ when flowers containing only stamens and those containing only pistils are produced in different places on the same plant.
7. ______________ plants have flowers on "two houses."
8. A ____________ flower is made of sepals, petals, stamens, and a pistil.
9. A plant having two seed leaves in each of its seeds is considered a ________________ .
10. When one or more of the four principal parts of a flower is absent, it is called a (an) ______________________ flower.
11. A flower is ____________ when both the stamens and the pistil are present.
12. A plant is classified as _________________ when the flowers bearing the stamens and those bearing the pistils are produced on separate plants.

STUDENT WORKSHEET #3 — Key

Classify Plants According to Flower Parts, Types of Flowers, and Other Methods

Fill in the blanks with the most appropriate answer.

1. Flowers that lack either the stamens or the pistil are called *imperfect* flowers.
2. *Monoecious* plants have flowers on "one house."
3. *Fibrous* root systems are very branched and finely divided.
4. A plant having only one seed leaf in each of its seeds is considered a *monocotyledon*.
5. *Tap* root systems have one major root.
6. A plant is classified as *monoecious* when flowers containing only stamens and those containing only pistils are produced in different places on the same plant.
7. *Dioecious* plants have flowers on "two houses."
8. A *complete* flower is made of sepals, petals, stamens, and a pistil.
9. A plant having two seed leaves in each of its seeds is considered a *dicotyledon*.
10. When one or more of the four principal parts of a flower is absent, it is called a (an) *incomplete* flower.
11. A flower is *perfect* when both the stamens and the pistil are present.
12. A plant is classified as *dioecious* when the flowers bearing the stamens and those bearing the pistils are produced on separate plants.

STUDENT WORKSHEET #4

Agricultural Classification

Write a brief description that will help you to remember how agriculturists commonly classify plants.

1. Cereals or Grain Crops

2. Oil Seed Crops

3. Forage and Pasture Crops

4. Root and Tuber Crops

5. Fiber Crops

6. Sugar Crops

7. Special Crops

STUDENT WORKSHEET #5

Common and Scientific Names of Plants

Listed below are several plants by their common name. Next to the common name of the plant, write its scientific name.

1. Purple Flowered Alfalfa —
2. Common Bermuda Grass —
3. Big Birdsfoot Trefoil —
4. Kentucky Bluegrass —
5. Alsike Clover —
6. Dent Corn —
7. Common Oats —
8. Rye —
9. Grain Sorghum —
10 Soybean —
11. Common White Sweetclover —
12. Durum Wheat —

STUDENT WORKSHEET #6

Identification of Crop Seeds

Seed Sample (Tape or Glue)	Characteristic of Seed and Plant	Monocot or Dicot Seed	Legume, Cereal, or Oil Grain

STUDENT WORKSHEET #7

Identification of Weed Seeds

Seed Sample (Tape or Glue)	Physical Characteristics of Seed and Plant (i.e., size, shape, color, etc.)	Primary Noxious; Secondary Noxious; Semiharmful; or Common Weed	Location Commonly Found (Field crop, pasture, etc.)

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CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Propagating Plants

RELATED PROBLEM AREAS:

1. Identifying Basic Principles of Plant Science (Central Core Cluster)
2. Understanding Plant Germination, Growth, and Development
3. Propagating Plants (Horticulture Cluster)
4. Understanding Plant Germination, Growth, and Development (Horticulture Cluster)

PREREQUISITE PROBLEM AREA(S):

1. Identifying Basic Principles of Plant Science (Central Core Cluster)

LEVEL: Preparatory

OCCUPATIONAL TASKS ADDRESSED:

Horticulture Cluster

Duty A: Propagating Plant, Seeds, and Cuttings

1. Take cuttings
2. Stick cuttings
3. Transplant cuttings

STATE GOALS FOR LEARNING:

In planning the instruction for this problem area, teachers can promote the development of several student learning objectives which are related to the State Goals for Learning in Biological and Physical Sciences. These objectives are listed on the Learning Assessment Plan forms included on the following page(s). Those learning objectives marked with an asterisk (*) are taken from the sample lists provided by the Illinois State Board of Education.

CORE

Illinois Agricultural Core Curriculum

Agricultural Education 124 Mumford Hall 1301 W. Gregory Drive University of Illinois Urbana, IL 61801

Director: Dale A. Law, Ed.D.
Principal Investigator: Jerry D. Pepple, Ed.D.
Research Assistant: Randy J. Bernhardt

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Submission Date ____________ ☐ Original submission ☐ Revision	Page ____ of ____

I. LEARNING AREA *(check one)*

☐ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☒ Sciences ☐ Physical Development/Health

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)

COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐

District Name

City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will have a working knowledge of the concepts and basic vocabulary of biological, physical, and environmental sciences and their application to life and work in contemporary technological society.

Contact Person: ____________
Title: ____________
Phone: ( )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Relate the parts of flowering plants and explain their functions.					
*2. Support the statement that living things receive their characteristics from the parent organism(s).					
3. Understand sexual reproduction of plants and the development of seeds and spores.					
4. Understand and perform techniques of cuttings.					
5. Understand and perform techniques of budding and grafting.					
1046				1047	

ISBE 41-78 (1/88)

Submission Date ____________________
☐ Original submission ☐ Revision
Page _____ of _____

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☒ Sciences ☐ Physical Development/Health

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)

COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐

District Name

City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will have a working knowledge of the social and environmental implications and limitations of technological development.

Contact Person: ____________________

Title: ____________________

Phone: ( )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Recognize the implications of modern genetic technology.					
2. Understand how hybrid corn is produced.					
1048					1049

Illinois Agricultural Core Curriculum Rev.

Propagating Plants

Agricultural Business and Management
Plant and Soil Science

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Propagating Plants

STUDENT LEARNING OBJECTIVES

Upon completion of their study of this problem area, students will be able to:

1. Understand sexual reproduction of plants and the development of seeds and spores.
2. Understand and perform techniques of cuttings.
3. Understand and perform techniques of budding and grafting.
4. Understand how hybrid corn is produced.

INSTRUCTOR'S NOTES AND REFERENCES

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INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Propagating Plants

PROBLEMS AND QUESTIONS FOR STUDY: **INSTRUCTOR'S NOTES AND REFERENCES**

1. What is trait inheritance in plants?
2. What are the parts of a flower?
3. What are the functions of flower parts?
4. What is sexual reproduction of plants?
5. What is asexual reproduction of plants?
6. How are seeds developed?
7. How are spores developed?
8. What does it mean to "take cuttings"?
9. How does one "take cuttings"?
10. What is budding?
11. What is grafting?
12. How are budding and grafting performed?
13. How is ground layering performed?
14. What agricultural crops are commonly reproduced by asexual means?
15. What is hybrid corn?
16. How is hybrid corn formed or developed?
17. What are the implications of corn hybridization (modern genetic technology)?

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INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Propagating Plants

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES

1. Discuss terminology for the problem area. Refer to Information Sheet #1.
2. Explain the parts of a flower and their functions. Use Information Sheet #2 and Transparency Master #1. Have students draw and label parts of a flower for reference.
3. Gather tulips (they are a large flower) and have students label all accessory and essential organs using dissecting pins to indicate the organs.
4. Refer to Information Sheet #1 for definitions of sexual and asexual reproduction.
5. Explain the process of fertilization. Transparency Master #2 explains the process. Use Transparency Master #1 to illustrate the fertilization process.
6. Discuss spore development in ferns. Refer to Information Sheet #3 and Transparency Master #3.
7. Emphasize the importance of sexual propagation of plants. See Transparency Master #4.
8. Discuss the reasons for using asexual propagation and the significance of clones. Refer to Information Sheet #4 and Transparency Master #5.
9. Discuss different types of asexual propagation. Refer to Transparency Masters #6 - #8.
10. For practical experience, have students conduct laboratory experiments on asexual reproduction.
11. Using Transparency Master #9, discuss plant species commonly reproduced by asexual means.
12. Begin discussion on hybrids. Ask students: What is a hybrid? How are hybrids formed? What are the implications of corn hybridization for the future?
13. Use Information Sheet #5 and Transparency Masters #10 and #11 to assist with the discussion of hybridization.
14. Take students on a field trip to a seed company's hybridization plots.
15. Locate summer employment for students detasseling corn hybridization plots.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Propagating Plants

REFERENCES:

INSTRUCTOR'S NOTES AND REFERENCES

1. *Producing Farm Crops*. (1981). Boone, Richer, Wilson. Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050.

*2. *Crop Production*. (1984). Delorit, Greub, Ahlgren. 5th edition. Prentice-Hall, 200 Old Tappan Road, Old Tappan, NJ 07675. (800) 223-2348.

*3. *Horticulture: A Basic Awareness*. (1982). Baudendistel, Robert F. Reston Publishing Company, Inc., A Prentice-Hall Company, 200 Old Tappan Road, Old Tappan, NJ 07675. (800) 223-2348.

*4. *Plant Propagation*. (1983). Hartmann and Kester. Prentice-Hall, 200 Old Tappan Road, Old Tappan, NJ 07675. (800) 223-2348.

5. *Plant Science: Growth, Development, and Utilization of Cultivated Plants*. (1981). Hartmann, Flocker, Kofranek. Prentice-Hall, 200 Old Tappan Road, Old Tappan, NJ 07675. (800) 223-2348.

*Indicates highly recommended reference

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INSTRUCTIONAL RESOURCES

These resources are intended for use by teachers in planning and teaching the materials for this problem area and may be adapted to fit the teaching method(s) used.

INFORMATION SHEET #1 — Terms to be Defined

INFORMATION SHEET #2 — Flower Part Functions

INFORMATION SHEET #3 — Spore Development

INFORMATION SHEET #4 — Reasons for Using Asexual (Vegetative) Propagation and Significance of Clones

INFORMATION SHEET #5 — Corn Hybrids

TRANSPARENCY MASTER #1 — Diagram of Flower Parts

TRANSPARENCY MASTER #2 — The Process of Sexual Reproduction in Plants

TRANSPARENCY MASTER #3 — Spore Development in Ferns

TRANSPARENCY MASTER #4 — Importance of Sexual Propagation of Plants

TRANSPARENCY MASTER #5 — Reasons for Using Asexual (Vegetative) Propagation, and Significance of Clones

TRANSPARENCY MASTER #6 — Types of Asexual Propagation

TRANSPARENCY MASTER #7 — Layering, and Cuttings

TRANSPARENCY MASTER #8 — Grafting and Budding

TRANSPARENCY MASTER #9 — Propagaton Methods for Important Plant Species

TRANSPARENCY MASTER #10 — Hybrid Formation

TRANSPARENCY MASTER #11 — Diagrams of Hybridization

INFORMATION SHEET #1

Terms to be Defined

Asexual reproduction — reproduction in which some portion of an established plant is used to obtain a new plant, which will be identical to its parent in all respects; also called vegetative reproduction.

Double or four-way hybrid — a hybrid produced by crossing two single-cross hybrids.

Hybrid — the offspring of two parents which differ in one or more heritable characters.

Inbreeding — the self-fertilization of plants to develop individuals which breed true for certain desirable characteristics.

Inheritance — deriving of traits from the parent(s).

Seed — ovule which gives origin to a new plant.

Sexual reproduction — combination of male and female gametes to form an offspring.

Single-cross hybrid — a hybrid produced by crossing two inbreds.

Spore — in ferns, minute cell with reproductive powers.

Three-way hybrid — a hybrid produced by crossing a single-cross hybrid with an inbred.

Trait — a distinguishing feature of a living thing.

INFORMATION SHEET #2

Flower Part Functions

Accessory Organs :

Calyx — composed of sepals, usually green in color; it is used to protect the interior flower parts.

Corolla — composed of petals. Bright colors are used to attract the bees and insects needed for pollination and eventual seed formation.

Essential Organs :

Stamen — male part consisting of a filament which is topped by an anther.

Filament — slender stalk which is topped by an anther.

Anther — part of the stamen which contains the pollen grains.

Pistil — female part consisting of a stigma, style, and ovary.

Stigma — tip which receives the pollen grains.

Style — area of the pistil between the stigma and the ovary consisting of a slender stalk down which the pollen passes.

Ovary — basal part of the pistil which may contain from one to many ovules of eggs.

INFORMATION SHEET #3

Spore Development

Reproduction by spores occurs in ferns. Two separate stages or generations are involved as shown in Transparency Master #3.

Spores are produced on the underside of fronds in clusters of sporangia, or spore cases, that appear as brownish "dots."

Each spore is haploid, with half the normal chromosome of the species.

Spores are discharged and under favorable temperature and moisture conditions "germinate" to produce the prothallus, a flat green plate of cells with small rootlike structures.

Male (antheridia) and female (archegonia) structures are produced on the underside of the same prothallus.

Sperm cells are discharged and, in the presence of water, are attracted into the archegonium to fuse with the egg and subsequently produce a zygote (new offspring).

The zygote develops into an embryo, which grows to produce the fern plant, which has the diploid chromosome number for the species.

INFORMATION SHEET #4

Reasons for Using Asexual (Vegetative) Propagation and Significance of Clones

Reasons for Using Asexual Propagation

1. Maintenance of Clones — The unique characteristics of any single plant are perpetuated during propagation.

2. Propagation of Seedless Plants — Asexual propagation is necessary to maintain cultivars that produce no viable seeds, such as some types of bananas, figs, oranges, and grapes.

3. Economics — In general, mass propagation by asexual means is not more economical than comparable propagation by seedlings, but its use is justified by the superiority and uniformity of specific clones. The major ecomony in vegetative propagation comes from the elimination of the juvenile phase and shortening of the time to reach reproductive maturity.

Significance of Clones

1. General Reasons for Using Clones — Cloning in agriculture makes possible the exploitation of a single superior plant with a unique gene type. All members of the clone generally have the same size, appearance, ripening time, blooming time, etc.

2. Examples of Successful Clones — Many commonly known cultivated crops today have been asexually propagated. Two examples are:

   a. "Bartlett" pear — This clone originated from a seedling in England about 1770.
   b. "Delicious" apple — This clone originated about 1870 in a chance seedling in an apple orchard in Peru, Iowa.

   By continuing the process of asexual propagation, millions of trees have since been grown whose characteristics are nearly identical to the orginal "Bartlett" and "Delicious" fruits.

INFORMATION SHEET #5

Corn Hybrids

Hybrid corn represents the most important single advance in the history of corn production. The superior yielding ability of hybrids and their continued improvement led to their rapid acceptance by farmers in the 1940s and 1950s. By 1960, hybrids comprised 96 percent of the corn acreage in the United States. Today practically all of the corn acreage is planted to hybrids.

How Hybrid Corn is Produced

The first step in producing hybrid corn is to develop pure lines or inbreds. This is accomplished by inbreeding or self-pollinating open-pollinated corn cultivars.

Corn is self-pollinated when the silks of a corn plant are pollinated by the pollen of the same plant.

Self-pollination or inbreeding is continued for five to seven years, during which time only the best plants are saved and those with undesirable traits are discarded.

Through rigid selection, the individual plants within the families derived through inbreeding become more and more alike until inbred lines breed true for desired qualities.

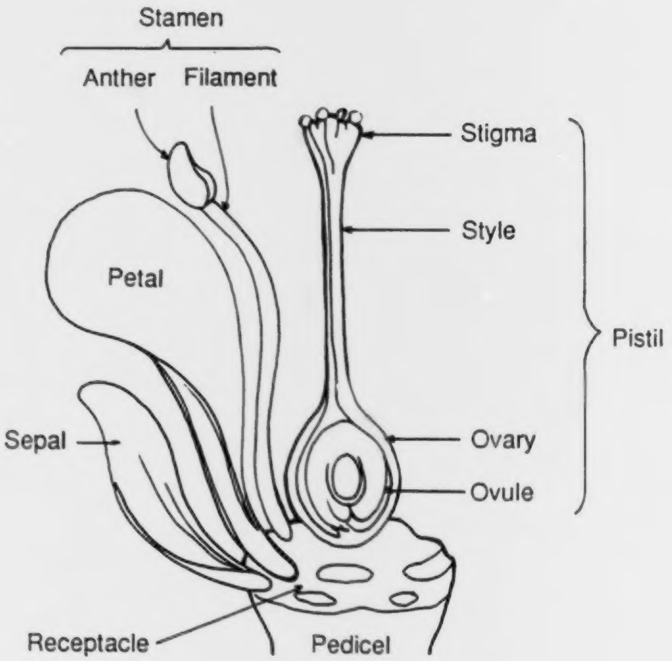
In commercial hybrid seed production, two pretested inbreds that combine well together are planted in alternating series of rows. The tassels of one inbred are rendered inoperative either by removing the tassels before pollen is shed or genetically through techniques effecting male sterility. The other inbred serves as the male.

The pollen from the male inbred pollinates the silks of the female inbred and the two inbreds have been crossed. The seed harvested from the female rows is known as a single-cross hybrid.

In addition to single-cross hybrids, three-way hybrids and double or four-way hybrids are grown for commercial hybrid seed corn production. (Refer to Information Sheet #1 for a description of a three-way and double or four-way hybrid.)

TRANSPARENCY MASTER #1

Diagram of Flower Parts


Stamen
Anther
Filament
Stigma
Style
Pistil
Petal
Sepal
Ovary
Ovule
Receptacle
Pedicel

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TRANSPARENCY MASTER #2

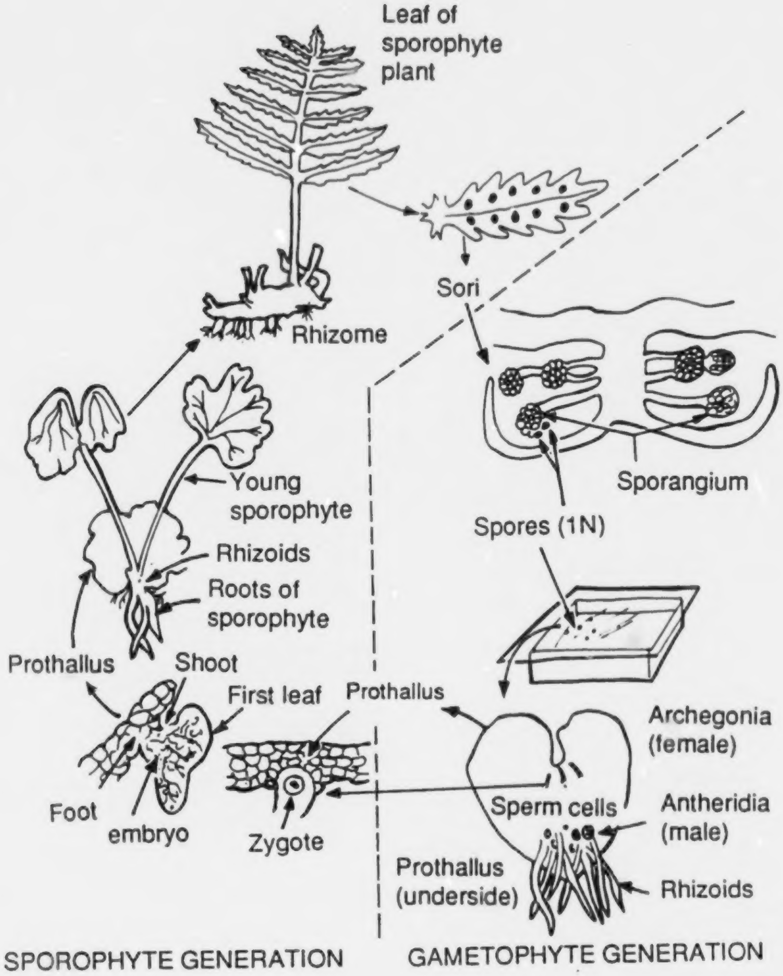
The Process of Sexual Reproduction in Plants

During flowering, pollen is transferred from the anther to the stigma (called pollination), where it germinates. A pollen tube grows down the style into the ovary until it reaches the embryo sac within the ovule. Two male gametes from the pollen tube are discharged into the embryo sac — one to unite with a female gamete (fertilization) to produce the offspring and another to unite with two polar nuclei to produce endosperm (food during initial stages of germination of seed).

1081

TRANSPARENCY MASTER #3

Spore Development in Ferns


Leaf of sporophyte plant
Sori
Rhizome
Sporangium
Spores (1N)
Young sporophyte
Rhizoids
Roots of sporophyte
Prothallus
Shoot
First leaf
Prothallus
Archegonia (female)
Foot
embryo
Zygote
Sperm cells
Antheridia (male)
Prothallus (underside)
Rhizoids
SPOROPHYTE GENERATION
GAMETOPHYTE GENERATION

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TRANSPARENCY MASTER #4

Importance of Sexual Propagation of Plants

Propagation by seeds is the major method by which plants reproduce in nature and one of the most efficient and widely used propagation methods for cultivated crops.

TRANSPARENCY MASTER #5

Reasons for Using Asexual (Vegetative) Propagation

1. Maintenance of Clones

2. Propagation of Seedless Plants

3. Economics

Significance of Clones

1. General Reasons for Using Clones

2. Examples of Successful Clones

    a. "Bartlett" Pear

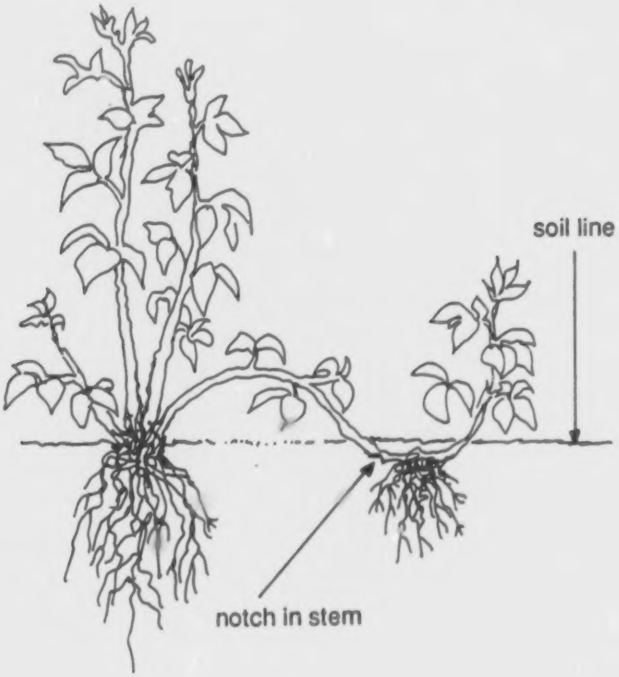
    b. "Delicious" Apple

TRANSPARENCY MASTER #6

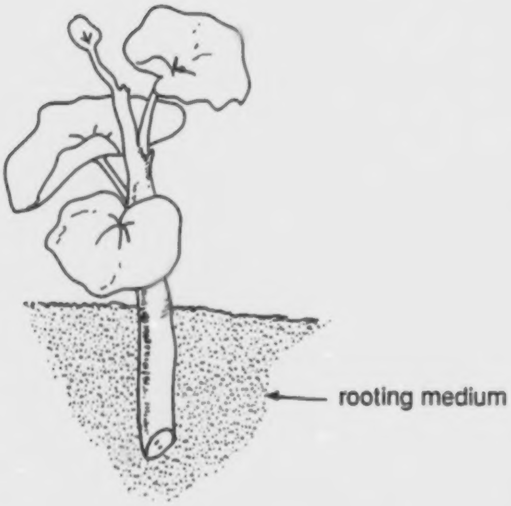
Types of Asexual Propagation

1. Stem Cuttings
2. Ground Layering
3. Serpentine Layering
4. Division
5. Root Cuttings
6. Bulbs
7. Corm
8. Tuber
9. Grafting
10. Budding or Bud Grafting

TRANSPARENCY MASTER #7

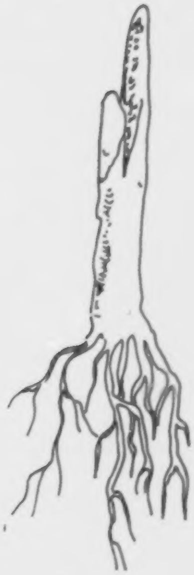

soil line
notch in stem

Layering

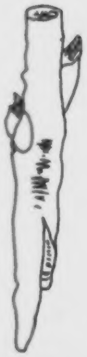

rooting medium

Cuttings

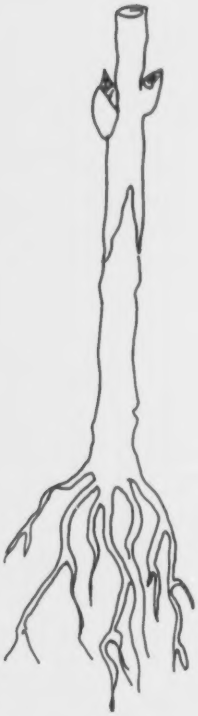
TRANSPARENCY MASTER #8



Stock (old)

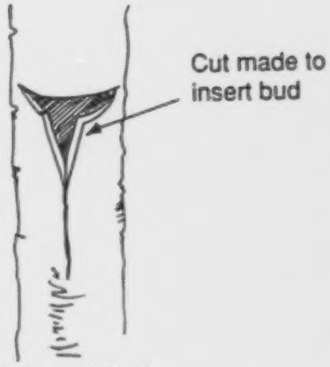


Scion (new)

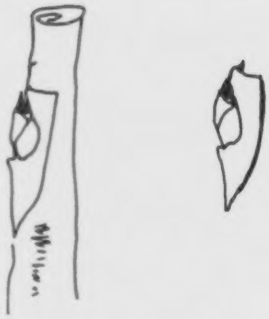


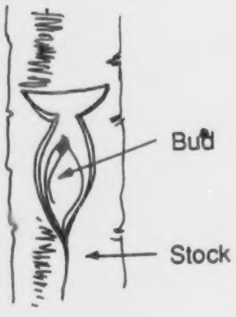
Union of stock and scion

Grafting


Cut made to
insert bud

Stems with buds





Budding

TRANSPARENCY MASTER #9

Propagation Methods for Important Plant Species

Plant	Propagation Method(s)
1. Apple	Budding
2. Apricot	Budding
3. Avocado	Budding or Grafting
4. Blackberry	Layering
5. Blueberry	Stem Cuttings
6. Cherry	Budding
7. Crabapple	Budding or Grafting
8. Cranberry	Cuttings
9. Currant	Stem Cuttings
10. Fig	Stem Cuttings
11. Gooseberry	Layering
12. Grape	Cuttings, Budding, Grafting
13. Mulberry	Cuttings
14. Peach and Nectarine	Budding and Root Grafting
15. Pear	Budding
16. Pecan	Budding or Grafting
17. Pistachio	Budding
18. Plum	Budding and Cuttings
19. Raspberry	Layering
20. Strawberry	Layering
21. Walnut	Budding or Grafting

TRANSPARENCY MASTER #10

Hybrid Formation

Single hybrid:

Inbred A x Inbred B

Single-cross hybrid AB

Three-way hybrid:

Inbred A x Inbred B

Single-cross hybrid AB

AB x Inbred C

Three-way hybrid ABC

Double or four-way hybrid:

Inbred A x Inbred B

Inbred C x Inbred D

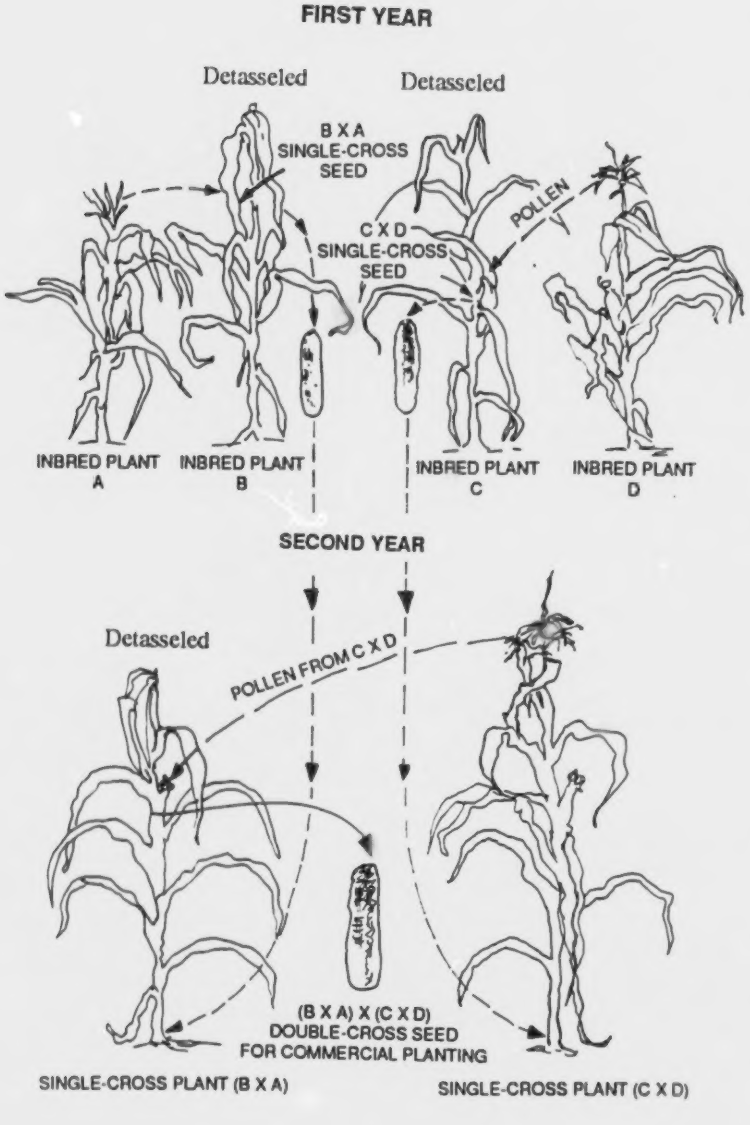
Single-cross hybrid AB x Single-cross hybrid CD

Double or four-way hybrid ABCD

Taken from *Crop Production*. Delorit, Greub, and Ahlgren. (1984). Prentice Hall, Allen & Bacon, 160 Gould St., Needham Heights, MA 02194-2310.

TRANSPARENCY MASTER #11

Diagrams of Hybridization


FIRST YEAR
Detasseled
Detasseled
B X A
SINGLE-CROSS
SEED
C X D
SINGLE-CROSS
SEED
POLLEN
INBRED PLANT
A
INBRED PLANT
B
INBRED PLANT
C
INBRED PLANT
D
SECOND YEAR
Detasseled
POLLEN FROM C X D
(B X A) X (C X D)
DOUBLE-CROSS SEED
FOR COMMERCIAL PLANTING
SINGLE-CROSS PLANT (B X A)
SINGLE-CROSS PLANT (C X D)

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STUDENT ACTIVITIES

STUDENT WORKSHEET #1 — Types of Asexual Propagation Word Search (with solution)

For additional activities, teachers may refer to the "Suggested Teaching Activities and Procedures" section in the Instructor's Guide.

STUDENT WORKSHEET #1

Types of Asexual Propagation Word Search

A	T	G	N	I	T	F	A	R	G	D	U	B	F	P	K	V	L	F
O	A	D	N	R	O	O	G	D	G	I	N	M	R	T	D	N	G	U
D	A	S	G	S	E	C	A	T	C	K	R	O	V	J	G	R	I	J
C	L	T	X	L	I	Y	G	A	F	O	P	K	L	N	O	W	J	U
V	A	E	U	I	A	E	A	G	C	A	O	U	S	U	B	C	M	W
I	P	M	M	O	E	U	K	L	G	F	B	B	N	Z	Z	S	B	P
D	T	C	A	V	T	K	X	A	E	S	X	D	I	N	G	U	Z	I
L	G	U	C	U	C	F	T	E	K	N	L	H	L	N	L	A	V	N
J	Q	T	D	N	U	I	C	Q	S	A	I	Q	I	B	Y	Q	G	L
X	X	T	O	L	O	I	M	G	Y	A	K	T	S	M	U	Q	G	M
S	X	I	J	N	K	R	R	E	X	R	T	D	N	U	X	N	O	B
T	F	N	H	E	R	A	R	W	J	U	I	C	A	E	I	R	L	J
S	I	G	R	P	F	I	L	Y	C	V	M	G	L	D	P	F	B	Q
L	I	S	W	T	N	C	T	T	I	L	M	R	D	Z	H	R	S	T
L	D	Y	I	G	D	G	O	S	V	P	I	U	P	G	A	Z	E	B
A	R	N	R	J	E	O	I	G	Z	J	B	N	M	T	E	Z	S	S
N	G	S	D	F	R	O	J	I	E	L	V	W	D	M	I	Q	B	B
P	D	X	N	J	N	Q	H	E	N	C	N	X	G	K	G	X	R	W
Y	Y	N	V	U	L	E	S	W	G	X	E	N	K	N	P	Z	E	X

The following words are hidden in the puzzle:

Asexual
Budding
Budgrafting
Bulbs
Corm
Division
Grafting
Ground Layering
Propagation
Root Cuttings
Serpentine Layer
Stem Cuttings

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STUDENT WORKSHEET #1 — Key

Types of Asexual Propagation Word Search

•	•	G	N	I	T	F	A	R	G	D	U	B	•	P	•	•	•	•
•	•	•	•	R	•	•	•	•	•	•	•	M	R	•	•	•	G	•
•	•	S	•	•	E	•	•	•	•	•	R	O	•	•	•	R	•	•
•	•	T	•	L	•	Y	•	•	•	O	P	•	•	•	O	•	•	•
•	•	E	•	•	A	•	A	•	C	A	•	•	•	U	•	•	•	•
•	•	M	•	•	•	U	•	L	G	•	•	•	N	•	•	S	B	•
•	•	C	•	•	•	•	X	A	E	•	•	D	•	•	G	U	•	•
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The following words are hidden in the puzzle:

- Asexual
- Budding
- Budgrafting
- Bulbs
- Corm
- Division
- Grafting
- Ground Layering
- Propagation
- Root Cuttings
- Serpentine Layer
- Stem Cuttings

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CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Understanding Plant Germination, Growth, and Development

RELATED PROBLEM AREA(S):

1. Identifying Basic Principles of Plant Sciences (Central Core Cluster)
2. Understanding Plant Germination, Growth, and Development (Horticulture Cluster)
3. Understanding Plant Anatomy and Physiology (Horticulture Cluster)

PREREQUISITE PROBLEM AREA(S): None

LEVEL: Preparatory

OCCUPATIONAL TASKS ADDRESSED:

Agricultural Business and Management Cluster

Duty J: Applying Fertilizers and Chemicals

1. Prepare fertilizer program
2. Prepare chemical program
3. Time fertilizer and chemical applications

Duty L: Growing Corn, Soybeans, Small Grains, or Forage Crops

1. Plan planting schedules
2. Select seed varieties
3. Select planting date
4. Prepare seed bed
5. Select planting method
6. Plant seeds
7. Monitor plant growth
8. Cultivate crop

STATE GOALS FOR LEARNING:

In planning the instruction for this problem area, teachers can promote the development of several student learning objectives which are related to the State Goals for Learning in Biological and Physical Sciences. These objectives are listed on the Learning Assessment Plan forms included on the following page(s). Those learning objectives marked with an asterisk (*) are taken from the sample lists provided by the Illinois State Board of Education.

Illinois Agricultural Core Curriculum

Agricultural Education 124 Mumford Hall 1301 W. Gregory Drive University of Illinois Urbana, IL 61801

Director: Dale A. Law, Ed.D.
Principal Investigator: Jerry D. Pepple, Ed.D.
Research Assistant: Randy J. Bernhardt

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Illinois Agricultural Core Curriculum Rev.

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date ______________
☐ **Original submission** ☐ **Revision**
Page ____ of ____

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☒ Sciences ☐ Physical Development/Health

(Affix label or complete district information.)
COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐
District Name
City

II. STATE GOAL FOR LEARNING
As a result of their schooling, students will have a working knowledge of the concepts and basic vocabulary of biological, physical, and environmental sciences and their application to life and work in contemporary technological society.

Contact Person: ______________
Title: ______________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Identify factors that affect seed germination.					
*2. Observe seed germination and the directional nature of plant growth.					
*3. Compare the growth responses of plants under differing environmental conditions.					
4. Understand the germination of seeds.					
5. Explain the manufacture, use, and storage of foods in plants.					
6. Understand the uptake of nutrients required by plants.					
7. Explain fertilization needs of small grains, corn, and soybeans.					
8. Understand the use of water by plants.					
9. Explain the life cycle of corn and bean plants.					
10. Develop an understanding of vegetative growth and development.					
11. Explain reproductive growth and development of plants.					
12. Obtain an understanding of plant growth regulators.					
13. Understand the effects of air pollution on plants.					
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Agricultural Business and Management
Plant and Soil Science

Understanding Plant Germination, Growth, and Development

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Understanding Plant Germination, Growth, and Development

STUDENT LEARNING OBJECTIVES

Upon completion of their study of this problem area, students will be able to:

1. Understand the germination of seeds.
2. Explain the manufacture, use, and storage of foods in plants.
3. Understand the uptake of nutrients required by plants.
4. Explain fertilization needs of small grains, corn, and soybeans.
5. Understand the use of water by plants.
6. Explain the life cycle of corn and bean plants.
7. Develop an understanding of vegetative growth and development.
8. Explain reproductive growth and development of plants.
9. Obtain an understanding of plant growth regulators.
10. Understand the effects of air pollution on plants.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Understanding Plant Germination, Growth, and Development

PROBLEMS AND QUESTIONS FOR STUDY

1. What is the definition of germination?
2. What are the factors that affect germination?
3. How would one conduct a germination laboratory?
4. What are the germination processes?
5. How do plants manufacture foods?
6. How do plants use foods?
7. How do plants store foods?
8. What nutrients are required by plants?
9. What are the fertilization needs of small grains?
10. What are the fertilization needs of corn?
11. What are the fertilization needs of soybeans?
12. What are the uses of water by plants?
13. What is the life cycle of corn plants?
14. What is the life cycle of bean plants?
15. What is vegetative growth and development?
16. What is reproductive growth and development of plants?
17. What are plant growth regulators? What are their functions?
18. What are the effects of air pollution on plants?

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Understanding Plant Germination, Growth, and Development

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES

1. Ask students to define plant germination. Use Transparency Master #1 to define germination.

2. Ask students to describe the process of germination. Refer to Information Sheet #1 and Transparency Master #2.

3. Discuss the factors that affect germination. Use Information Sheet #2 and Transparency Master #3.

4. Have students complete Student Worksheet #1.

5. Discuss the manufacture, use, and storage of food in plants. Refer to Information Sheet #3 and Transparency Master #4. Transparency Master #5 shows the place of food storage in certain plants. Students should complete Student Worksheet #2.

6. Using Information Sheet #4 and Transparency Master #6, begin a discussion about the nutrients required by plants. Student Worksheet #3 is a matching activity on plant nutrients and their chemical symbols.

7. To discuss and have students learn about fertility needs of small grains, corn, and soybeans, refer to the VAS Units listed in the references; the VAS Packet *Soybeans —Planting to Harvest*; and *Crop Production*, by Delorit, Greub, and Ahlgren (see reference list). Also have students do the activity "Buckle Up Your Corn Belt: A Lesson in U.S. Crop Regions," in *Agricultural Basics in Education, Classroom Lessons on Illinois Agriculture* (see references).

8. Ask students, "What are the uses of water by plants?" Using Information Sheet #5 and Transparency Master #7, discuss this topic. Set up and conduct mini-laboratories in the area of osmosis and cohesion/adhesion. Refer to Student Worksheet #4.

9. Use Information Sheet #6 and Transparency Masters #8 - #11 to discuss dicot seed parts, parts of a dicot plant, and the life cycle of a bean plant.

10. Use Information Sheet #6 and Transparency Masters #12 - #14 to discuss monocot seed parts, parts of a monocot plant, and the life cycle of a corn plant.

11. For a laboratory on germination and identification of plant parts of monocot and dicot plants, refer to Student Worksheet #5.

12. Discuss the life cycle of a typical annual plant from germination to mature seed. Refer to Transparency Master #15.

13. Explain general terminology and terminology and processes of vegetative growth and development. Refer to Information Sheets #7 and #8 and Transparency Master #16.

14. Discuss reproductive growth and development of plants. Use Information Sheet #9 and Transparency Masters #17 and #18 for this topic.

15. Have students answer and complete Student Worksheet #6.

16. Discuss plant growth regulators. Refer to Information Sheet #10, Transparency Master #19, and Student Worksheet #7. As each plant growth regulator is discussed in class, have students include on their worksheet a description of the plant growth regulator's effects on plants.

17. Conduct a laboratory on the effect of soil types on seed germination. Refer to Student Worksheet #8.

18. Conduct a laboratory on the effect of growth regulators on plant growth.

19. Using Information Sheet #11 and Transparency Master #20, discuss the effects of air pollution on plants.

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Understanding Plant Germination, Growth, and Development

REFERENCES

1. *Agricultural Basics in Education, Classroom Lessons on Illinois Agriculture.* (1986). Lewis, John L., Project Director. Illinois Council on Economic Education, Northern Illinois University, Dekalb, IL.

*2. *Plant Science: Growth, Development, and Utilization of Cultivated Plants.* (1981). Hartmann, Flocker, Kofranek. Prentice-Hall, Inc., 200 Old Tappan Road, Old Tappan, NJ 07675. (800) 223-2348.

3. *Producing Farm Crops.* (1981). Boone, Richer, Wilson. Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

4. *Horticulture: A Basic Awareness.* (1982). Baudendistel, Robert F. Reston Publishing Company, Inc., Division of Prentice-Hall, 200 Old Tappan Road, Old Tappan, NJ 07675. (800) 223-2348.

*5. *Crop Production.* (1984). Delorit, Greub, Ahlgren. 5th edition. Prentice-Hall, Inc., 200 Old Tappan Road, Old Tappan, NJ 07675. (800) 223-2348.

6. *Growing Oats* (VAS Unit #U4023B); *Growing Wheat* (VAS Unit #U4027B); *Planting and Growing Corn* (VAS Unit #U4039A). Vocational Agriculture Service, College of Agriculture, University of Illinois, 1401 S. Maryland Drive, Urbana, IL 61801. (217) 333-3871.

*Indicates highly recommended reference

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTIONAL RESOURCES

These resources are intended for use by teachers in planning and teaching the materials for this problem area and may be adapted to fit the teaching method(s) used.

INFORMATION SHEET #1 — Germination Processes

INFORMATION SHEET #2 — Factors that Affect Germination

INFORMATION SHEET #3 — The Manufacture, Use, and Storage of Food in Plants

INFORMATION SHEET #4 — Nutrients Required by Plants

INFORMATION SHEET #5 — The Use of Water by Plants

INFORMATION SHEET #6 — Identification of Parts of the Soybean Seed and Plant, and Identification of Parts of the Corn Seed and Plant

INFORMATION SHEET #7 — Terms to be Defined

INFORMATION SHEET #8 — Vegetative Growth and Development

INFORMATION SHEET #9 — Reproductive Growth and Development

INFORMATION SHEET #10 — Plant Growth Regulators

INFORMATION SHEET #11 — The Effects of Air Pollution on Plants

TRANSPARENCY MASTER #1 — Germination Defined

TRANSPARENCY MASTER #2 — Germination Processes

TRANSPARENCY MASTER #3 — Factors that Affect Germination

TRANSPARENCY MASTER #4 — The Manufacture, Use, and Storage of Food in Plants

TRANSPARENCY MASTER #5 — Food Storage Sites in Some Common Vegetable and Fruit Species

TRANSPARENCY MASTER #6 — Elements Necessary for Plant Growth

TRANSPARENCY MASTER #7 — The Use of Water by Plants

TRANSPARENCY MASTER #8 — Parts of a Soybean Seed

TRANSPARENCY MASTER #9 — Growth of a Dicot Seed

TRANSPARENCY MASTER #10 — Parts of a Young Soybean Plant

TRANSPARENCY MASTER #11 — Life Cycle of a Bean Plant

TRANSPARENCY MASTER #12 — Germination of a Monocot Seed

TRANSPARENCY MASTER #13 — The Young Corn Plant

TRANSPARENCY MASTER #14 — Life Cycle of a Corn Plant

TRANSPARENCY MASTER #15 — Life Cycle from Germination to Mature Seed

TRANSPARENCY MASTER #16 — Vegetative Growth and Development

TRANSPARENCY MASTER #17 — Reproductive Growth and Development

TRANSPARENCY MASTER #18 — Pistil of a Flower Following Pollination and Just Before Fertilization

TRANSPARENCY MASTER #19 — Plant Growth Regulators

TRANSPARENCY MASTER #20 — The Effects of Air Pollution on Plants

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INFORMATION SHEET #1

Germination Processes

1. The seed swells and increases in size as it absorbs water from the soil.
2. Enzymes are secreted that have the ability to change starches to sugars. These are used by the young plant or embryo as a source of food.
3. Rupture of the seed coat follows in two to four days.
4. The young plant emerges from the seed. The young plant makes use of the stored foods that the seed contains to continue growth.
5. Roots grow downward into the soil from the lower part of the plant.
6. The upper part of the plant penetrates through the soil and emerges at the surface.

INFORMATION SHEET #2

Factors that Affect Germination

1. Temperature — The most favorable temperature for germination varies with the crop. Some crops require a fairly high temperature for good germination; others germinate well at lower temperatures.

2. Sufficient Moisture — Excess moisture in the soil may prevent or reduce germination because of a deficiency of air, which is driven out as the water accumulates.

3. Presence of Oxygen or Air — Air contains oxygen, which is necessary for germination. Excess moisture and deep planting or development of a crust on the soil surface may prevent sufficient oxygen from reaching the seed.

4. Light — Light especially of the red wavelengths has been found to stimulate germination.

5. Miscellaneous Factors — Carbon dioxide and other ingredients present in the soil can affect seed germination in complex ways.

INFORMATION SHEET #3

The Manufacture, Use and Storage of Food in Plants

1. Definition of Photosynthesis

   "Photo" refers to light and "synthesis" means building or putting together. Thus, photosynthesis can be interpreted to mean that "the plant builds food in the presence of light."

2. Requirements for Photosynthesis to Occur

   a. The availability of sufficient light, carbon dioxide, water, and other essential nutrients.

   b. A favorable temperature.

   c. The presence of living cells that contain chlorophyll.

3. Photosynthesis Chemical Equation

$$\begin{array}{ccccccccccc} 6CO_2 & + & 12H_2O & + & \text{Light} & \rightarrow & C_6H_{12}O_6 & + & 6H_2O & + & 6O_2 \\ \text{Carbon Dioxide} & & \text{Water} & & & & \text{Glucose} & & \text{Water} & & \text{Oxygen} \end{array}$$

4. Two Processes of Photosynthesis

   a. Photochemical — Chlorophyll absorbs sunlight and converts the light energy into chemical energy useable to the plants.

   b. Synthesis of Glucose — The plant's cells use chemical energy to bring about the synthesis of glucose from carbon dioxide and hydrogen. The photosynthate (food manufactured in the leaves by the chlorophyll) may be transported to other parts of the plant.

5. Definition of Respiration

   Not all food manufactured by the plant is used to build new tissues. Some is needed to provide the energy that the plant requires for carrying on its many functions. The energy the plant requires is released for the plant's use through the process of respiration.

6. Result of Respiration

   Respiration is a function conducted by all living organisms that require oxygen to live and is referred to as aerobic respiration. The net result of respiration is:

   a. Oxidation of glucose molecules.

   b. Formation of carbon dioxide and water.

   c. The release of energy to the cell.

7. Respiration Chemical Equation

$$\begin{array}{ccccccccc} C_6H_{12}O_6 & + & 6O_2 & \rightarrow & 6CO_2 & + & 6H_2O & + & \text{Energy} \\ \text{Glucose} & & \text{Oxygen} & & \text{Carbon Dioxide} & & \text{Water} & & \end{array}$$

   It is estimated that about 25 percent of food manufactured in leaves is used to provide energy required by the plant.

8. Food Storage

   Food materials manufactured by the plants as a result of photosynthesis and not used as building materials or as a source of energy are stored. These stored food products are of three basic types:

   a. Carbohydrates (such as starches, fructosans, and sugars)

   b. Proteins

   c. Fats or oils

INFORMATION SHEET #4

Nutrients Required by Plants

1. Absorption of Carbon Dioxide by Plants

Carbon dioxide moves into the leaves of a plant by diffusion. Gas diffusion is similar to liquid diffusion. To demonstrate liquid diffusion, do the following mini-laboratory.

Place a drop of ink in a beaker of water and observe the ink move out slowly in all directions, eventually coloring the water uniformly.

Diffusion is the movement of a substance from an area of high concentration to an area of low concentration.

2. Absorption of Mineral Elements by Plants

The mineral elements available to plants are either dissolved in the soil water to form the soil solution or they are held on the ion exchange sites of the clay particles and organic matter.

3. Nitrogen Fixation Among Legume Species

Within the legume family of plants, there are many species which, through the aid of certain bacteria, are able to use atmospheric nitrogen in their growth. The atmosphere is approximately 78% nitrogen by volume and a tremendous potential exists for such plants to utilize this free source of nitrogen.

INFORMATION SHEET #5

The Use of Water by Plants

1. Water Absorption

The movement of water from the soil into the root cells is due mainly to osmosis. Osmosis is defined as the diffusion or movement of a substance from a place of greater concentration through a differentially permeable membrane to a place of lesser concentration.

2. Transpiration

The loss of water from within the leaf to the atmosphere is called transpiration. It is a special type of evaporation.

Transpiration has a cooling effect on leaves and prevents leaf temperatures from increasing too high. If this didn't happen the growth rate would be reduced.

3. Water Movement

Once water is absorbed by the roots, it moves to the various branches and leaves. The water column is kept intact by cohesion as it moves upward through the xylem. Cohesion is the attraction of water molecules for each other. Root pressure caused by water entering the root cells by osmosis and the adhesion between water and the xylem vessel wall also contribute to the upward movement of water.

INFORMATION SHEET #6

Identification of Parts of the Soybean Seed and Plant, and Identification of Parts of the Corn Seed and Plant

Parts of the Soybean Seed and Plant

1. The function of the seed coat is to protect the embryo from fungi and bacteria.
2. The cotyledons supply food to the seedling plant.
3. The radicle is the primary root of the plant.
4. The hypocotyl is the main stem and growing point of the soybean plant.

Parts of the Corn Seed and Plant

1. The seed coat (hull) protects the embryo from insects and diseases.
2. The endosperm provides food for the young plant.
3. The embryo is a young immature plant.

INFORMATION SHEET #7

Terms to be Defined

Cytokinesis — division of the resulting binucleate cell into two uninucleate cells.

Evapotranspiration — the total soil water loss by transpiration from the plant leaves and evaporation from the soil.

Mitosis — the division of one nucleus into two nuclei.

Photoperiodism — the physiological responses of plants to variations of light and darkness.

Phototropism — the movement or bending of stems, leaves, and flowers toward light.

Regulatory/operator genes — genes involved in regulating the activity of the structural genes. See structural genes.

Structural genes — genes involved in protein synthesis.

INFORMATION SHEET #8

Vegetative Growth and Development

1. Plant Growth

   The importance of meristems in the growth of plants must be clearly understood. In dicotyledenous plants, vegetative buds at the shoot tips and in the axils of leaves contain meristematic cells that are capable of dividing and redividing, by mitosis and cytokinesis, producing millions of cells along a longitudinal axis. Cell division, together with cell elongation, causes the shoots to grow.

2. Genetic Factors Affecting Plant Growth and Development

   As the plant enlarges from the fertilized egg (zygote) to its mature size, many developmental processes take place.

   Certain segments of DNA (genes) direct the synthesis of enzymes that catalyze specific biochemical reactions required for growth and development. Types of genes include:

   a. Structural Genes — genes involved in protein synthesis.

   b. Regulatory/Operator Genes — genes involved in regulating the activity of the structural genes.

3. Environmental Factors Affecting Plant Growth and Development

   a. Light — The sun is the source of energy for photosynthesis and other plant processes.

      1) Phototropism — the movement or bending of stems, leaves, and flowers toward light.

      2) Photoperiodism — refers to the physiological responses of plants to variations of light and darkness.

   b. Temperature — All plants have optimal temperatures for maximum vegetative growth and flowering.

   c. Water — Most growing plants contain about 90 percent water, which is stored in various plant tissues and is used as one of the raw materials for photosynthesis.

      1) Evapotranspiration — the total soil water loss by transpiration of the plant and evaporation of water from the soil.

   d. Gases — The two gases most important to the growth of green plants are oxygen (O_2) and carbon dioxide (CO_2).

      1) CO_2 — used by green plants for photosynthesis.

      2) O_2 — important in the respiration of all plant parts.

4. Juvenility, Maturation, and Senescence

   Seedling plants pass through embryonic growth, juvenility, a transition stage, maturity, senescence, and death.

   Morphological changes of age are accompanied by important physiological changes.

   a. Juvenile Stage — A primary criterion for judging that a plant is in the juvenile stage is its inability to form flowers and set fruit even through all environmental conditions are conducive to flowering.

      The onset of flowering and fruiting indicates the termination of the juvenile phase.

   b. Aging and Senescence — The life spans of different kinds of flowering plants differ greatly, ranging from a few months to thousands of years.

      1) Senescence — a terminal, irreversible deteriorative change in living organisms, leading to cellular and tissue breakdown and death. Senescence is usually considered to be caused by inherent physiological changes in the plant, but it can also be caused by pathogenic attack or environmental stress.

INFORMATION SHEET #9

Reproductive Growth and Development

1. Flower Induction and Initiation

   Once mature, the plant can be induced to flower by becoming sensitive to the conditions of the environment.

   a. Length of Day

      1) Short-day plants — plants that require short days for flower induction.

      2) Long-day plants — plants that require long days for flower induction.

      3) Day-neutral plants — plants in which flower induction is not affected by length of day.

   b. Vernalization — Flower induction occurs after a shortened growth period because of lowered temperatures.

2. Pollination — The transfer of pollen from an anther to a stigma.

   a. Self-pollination — There are three types of self-pollination.

      1) The anther and stigma are on the same flower.

      2) The anther and stigma are on different flowers on the same plant.

      3) The anther and stigma are on different flowers on different plants of the same cultivar.

   b. Cross-pollination — The anther and stigma are on different flowers on plants of different cultivars.

3. Fertilization — In angiosperms, one pollen tube unites with the egg to form the zygote, which will eventually become the new plant. The other sperm nucleus unites with the two polar nuclei in the embryo sac to form the endosperm, which develops into food storage tissue. This is called double fertilization (refer to Transparency Master #17).

4. Fruit Setting — Setting is the initial development of fruit after fertilization has occurred.

5. Fruit Growth and Development — Once fruit has set, the true fruit and sometimes various associated tissues begin to grow. Food materials move from other parts of the plant into these developing tissues.

INFORMATION SHEET #10

Plant Growth Regulators

There are five recognized groups of natural plant hormones:

1. Auxins — influence plant growth in many ways, including cell enlargement or elongation, photo- and geotropism, abscission of plant parts, flower initiation and development, root initiation, fruit set and growth, tuber and bud formation, and seed germination. Both natural and synthetic forms exist.

2. Gibberellins — stimulate stem growth dramatically, far more than auxins can; may stimulate cell division and cell elongation, and can control enzyme secretion.

3. Cytokinins — primarily promote cell division but also participate in many aspects of plant growth and development, such as cell enlargement, tissue differentiation, dormancy, different phases of flowering and fruiting, and retardation of leaf senescence.

4. Ethylene — evokes many responses in plants, such as the overcoming of bud dormancy, inducement of leaf abscission, induction of flowering, and formation of roots on stem cuttings.

5. Abscisic Acid — interacts with other hormones in the plant, inhibiting the growth-promoting effects of auxins and gibberellins; involved in leaf and fruit abscission, as well as the onset of dormancy in seeds and the early stages of the rest period in vegetative and flower buds of wood perennial shrubs and trees.

INFORMATION SHEET #11

The Effects of Air Pollution on Plants

1. Extent of the problem

   Pollution causes increased plant losses every year. During recent years the problem has become more widespread.

2. Pollutants and their damage

   Black smoke seen from smokestacks, diesel trucks, buses, and rubbish incinerators usually is not the main problem.

   Invisible chemical compounds such as sulfur dioxide, hydrogen fluoride, ozone, nitrogen dioxide, ethylene, and peroxyacetyl nitrates in smog are most injurious to plants.

   Many air pollution symptoms appear very similar to those resulting from herbicide damage, mineral deficiencies, plant disease, frost injury, and insect damage.

   The source of many of these problems is the burning of fossil fuels.

3. Reducing air pollution effects

   Some species are more resistant to air pollution than others.

   Certain chemical compounds such as ozoban and ascorbic acid, when sprayed on plants, have been found to reduce air pollution effects.

   Fungicides have also been found to provide protection from air pollution.

   Plant breeders may be able to develop cultivars of crop plants that are resistant to various effects of air pollution.

TRANSPARENCY MASTER #1

Germination Defined

Germination — The resumption of growth by the embyro in a seed or by a spore when placed under favorable conditions.

TRANSPARENCY MASTER #2

Germination Processes

1. Water Absorption
2. Enzyme Secretion
3. Seed Coat Rupture
4. Emergence from the Seed
5. Root Growth
6. Plant Emergence at the Soil Surface

TRANSPARENCY MASTER #3

Factors That Affect Germination

1. Temperature

2. Sufficient Moisture

3. Presence of Oxygen or Air

4. Light

5. Miscellaneous Factors

TRANSPARENCY MASTER #4

The Manufacture, Use, and Storage of Food in Plants

1. Definition of Photosynthesis

2. Requirements of Photosynthesis

3. Photosynthesis Chemical Equation

$6CO_2$	+	$12H_2O$	+	Light	→	$C_6H_{12}O_6$	+	$6H_2O$	+	$6O_2$
Carbon Dioxide		Water				Glucose		Water		Oxygen

4. Two Processes of Photosynthesis

   a. Photochemical
   b. Synthesis of Glucose

5. Definition of Respiration

6. Result of Respiration

7. Respiration Chemical Equation

$C_6H_{12}O_6$	+	60_2	→	$6C0_2$	+	$6H_20$	+	Energy
Glucose		Oxygen		Carbon Dioxide		Water		

8. Food Storage

   a. Carbohydrates
   b. Proteins
   c. Fats or Oils

TRANSPARENCY MASTER #5

Food Storage Sites in Some Common Vegetable and Fruit Species

Place of Storage	*Examples*
Buds	Brussels sprout
Floral parts	Cauliflower and broccoli
Leaves	Lettuce, parsley, cabbage, rape, and kale
Ovary wall and contents	Green bean and wax bean
Petioles of leaves	Rhubarb and celery
A portion or all of the ovary wall	Squash, pumpkin, watermelon, cantaloupe, peach, plum, cherry, olive, apricot, eggplant, cucumber, banana, and tomato
Receptacle of flower	Strawberry, apple, and pear
Root and hypocotyl	Carrot, parsnip, turnip, rutabaga, and sugar beet
Root or rhizome	Irish potato and sweet potato
Stems and leaves	Asparagus, onion, and kohlrabi

1099

TRANSPARENCY MASTER #6

Elements Necessary For Plant Growth

Element	*Symbol*	*Form In Which the Element is Taken Up, and the Usual Source*
Boron	B	Borate ($BO_3^{=}$) ions in the soil
Calcium	Ca	Calcium (Ca^{++}) ions in the soil
Carbon	C	Carbon dioxide (CO_2) gas in the atmosphere
Chlorine	Cl	Chloride (Cl^{-}) ions in the soil
Copper	Cu	Cupric (Cu^{++}) ions in the soil
Hydrogen	H	Soil water, in combination with other elements taken up by the roots, or hydrogen (H^{+}) ions in the soil
Iron	Fe	Ferrous (Fe^{++}) ions in the soil
Magnesium	Mg	Magnesium (Mg^{++}) ions in the soil
Manganese	Mn	Manganese (Mn^{++}) ions in the soil
Molybdenum	Mo	Molybdenate ($MoO_4^{=}$) ions in the soil
Nitrogen	N	Nitrate (NO_3^{-}) and ammonium (NH_4^{-}) ions in the soil, except for nodulated legumes which use nitrogen gas (N_2) directly from the air in the soil
Oxygen	O	Oxygen(O_2) gas in the atmosphere and soil, or from the breakdown of oxygen-containing compounds including water
Potassium	K	Potassium (K^{+}) ions in the soil
Phosphorus	P	Primary ($H_2PO_4^{-}$) and secondary ($HPO_4^{=}$) orthophosphate ions in the soil
Sulfur	S	Sulfate ($SO_4^{=}$) ions in the soil
Zinc	Zn	Zinc (Zn^{++}) ions in the soil

TRANSPARENCY MASTER #7

The Use of Water by Plants

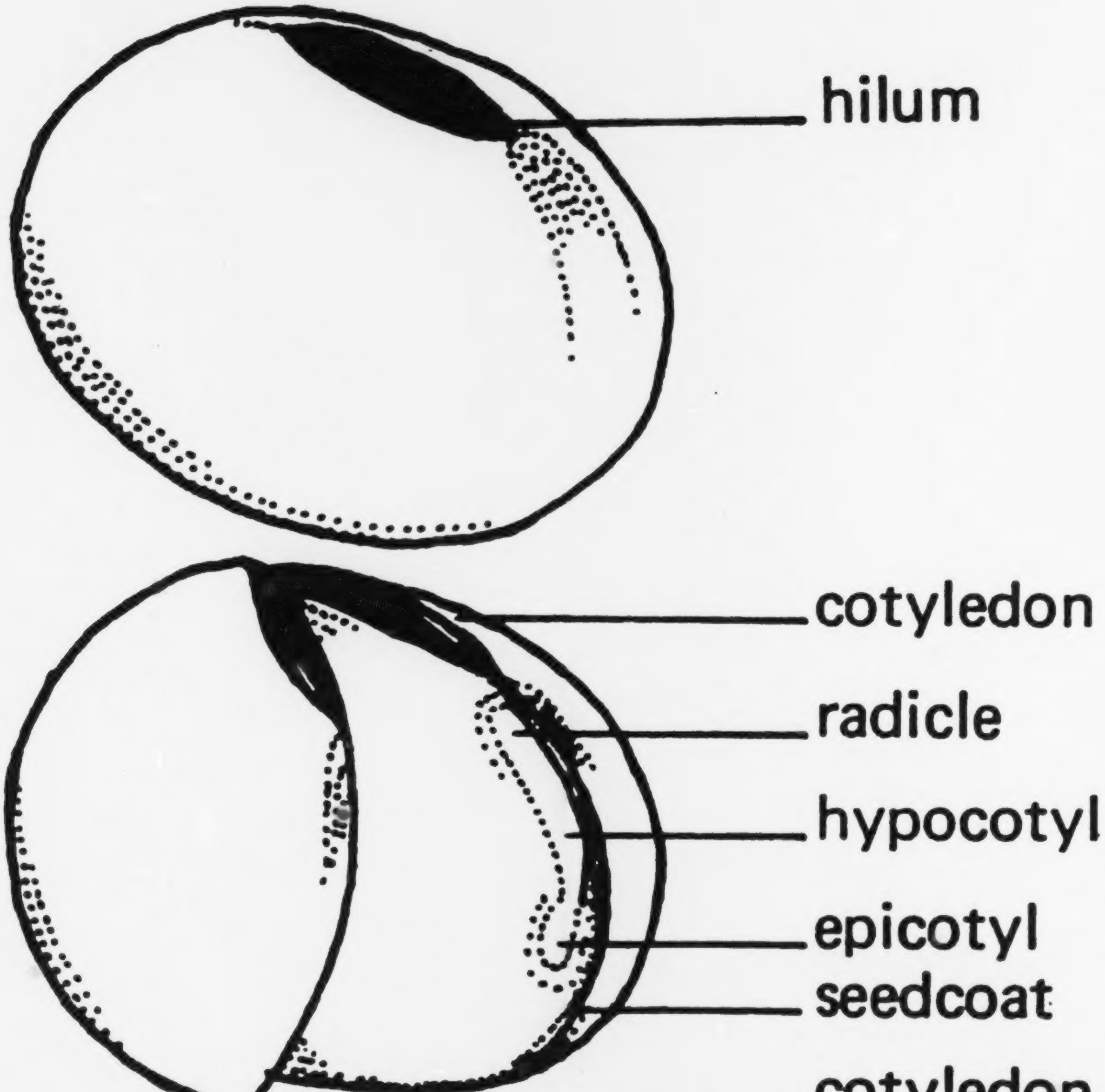
1. Water Absorption

2. Transpiration

3. Water Movement

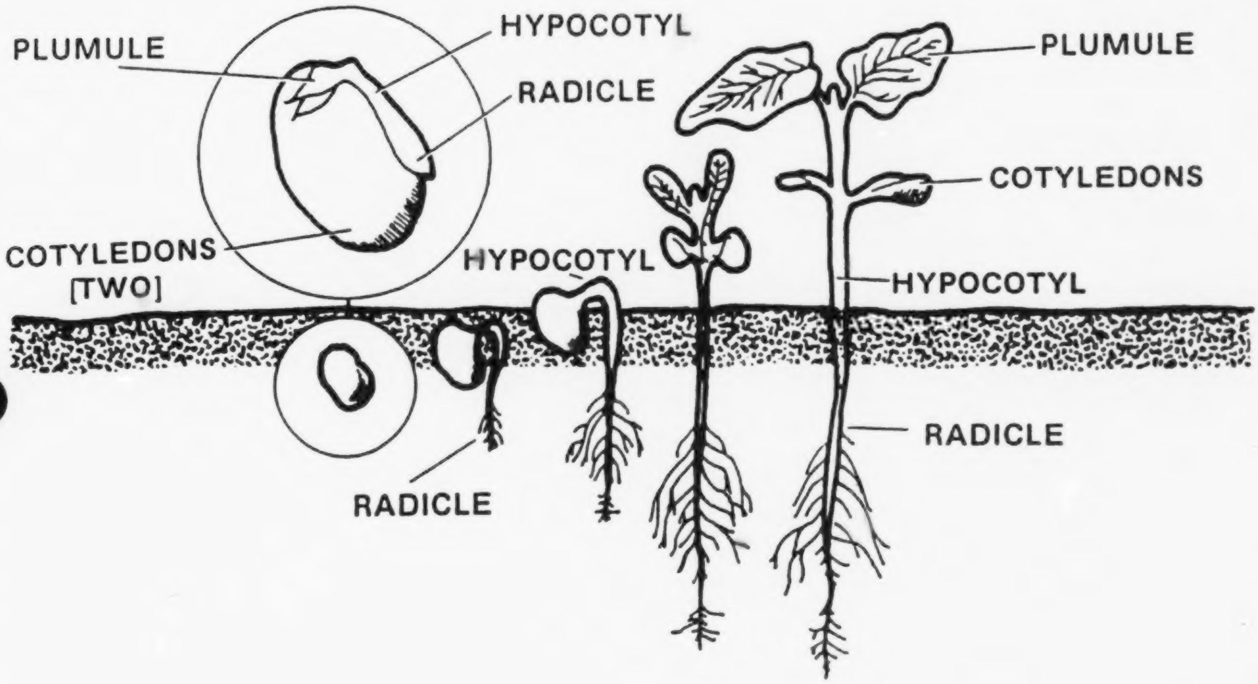
TRANSPARENCY MASTER #8

Parts of A Soybean Seed


hilum
cotyledon
radicle
hypocotyl
epicotyl
seedcoat
cotyledon

TRANSPARENCY MASTER #9

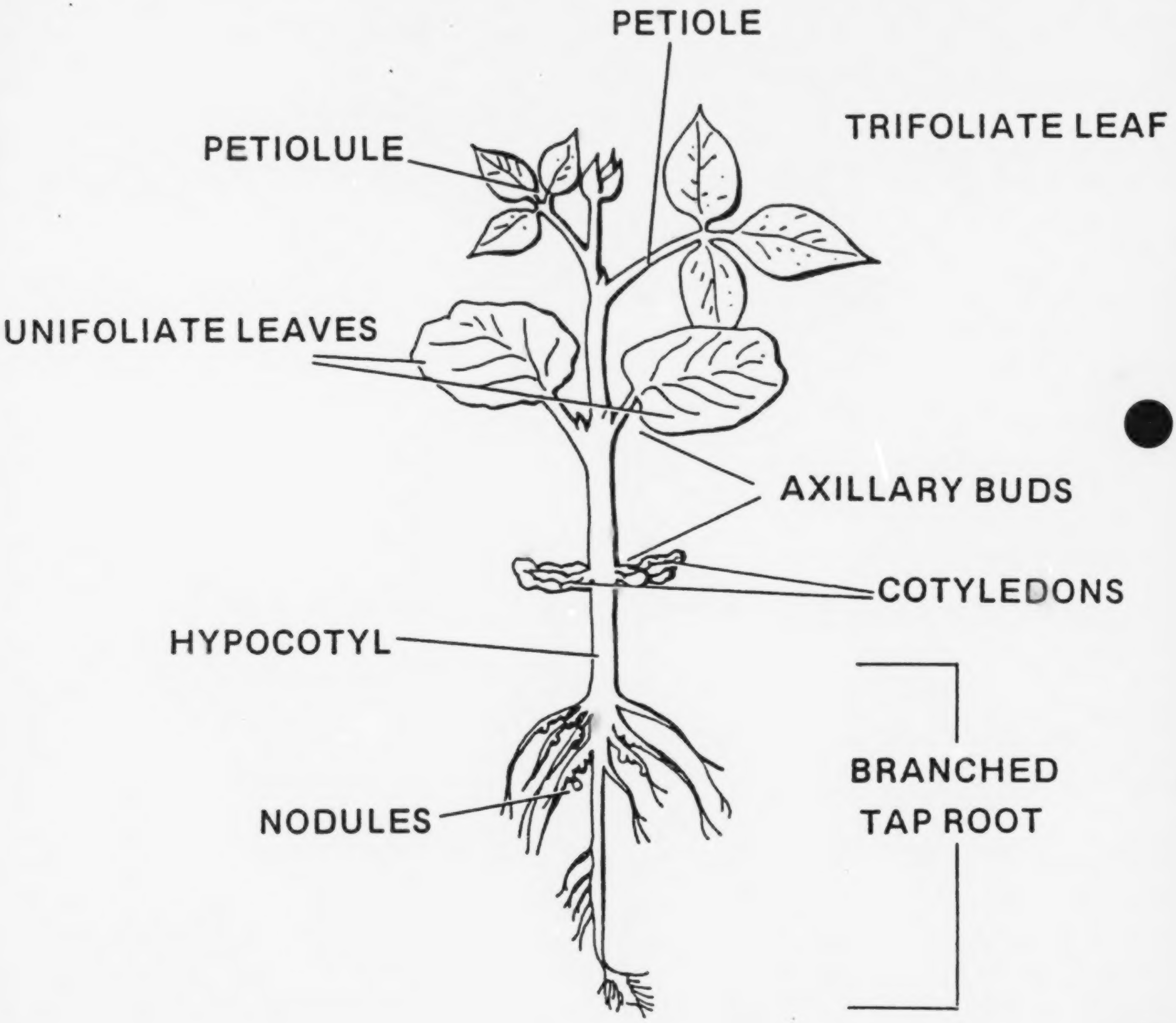
Growth of a Dicot Seed


PLUMULE
HYPOCOTYL
RADICLE
COTYLEDONS
[TWO]
HYPOCOTYL
RADICLE
PLUMULE
COTYLEDONS
HYPOCOTYL
RADICLE

1102

TRANSPARENCY MASTER #10

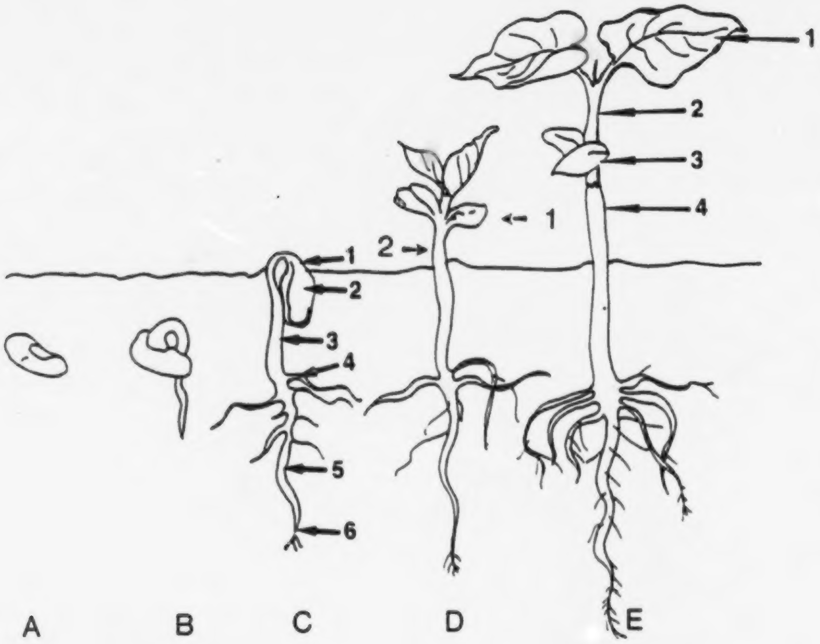
Parts of A Young Soybean Plant


PETIOLE
TRIFOLIATE LEAF
PETIOLULE
UNIFOLIATE LEAVES
AXILLARY BUDS
COTYLEDONS
HYPOCOTYL
BRANCHED TAP ROOT
NODULES

1103

TRANSPARENCY MASTER #11

Life Cycle of A Bean Plant



Common Bean Germination and Growth

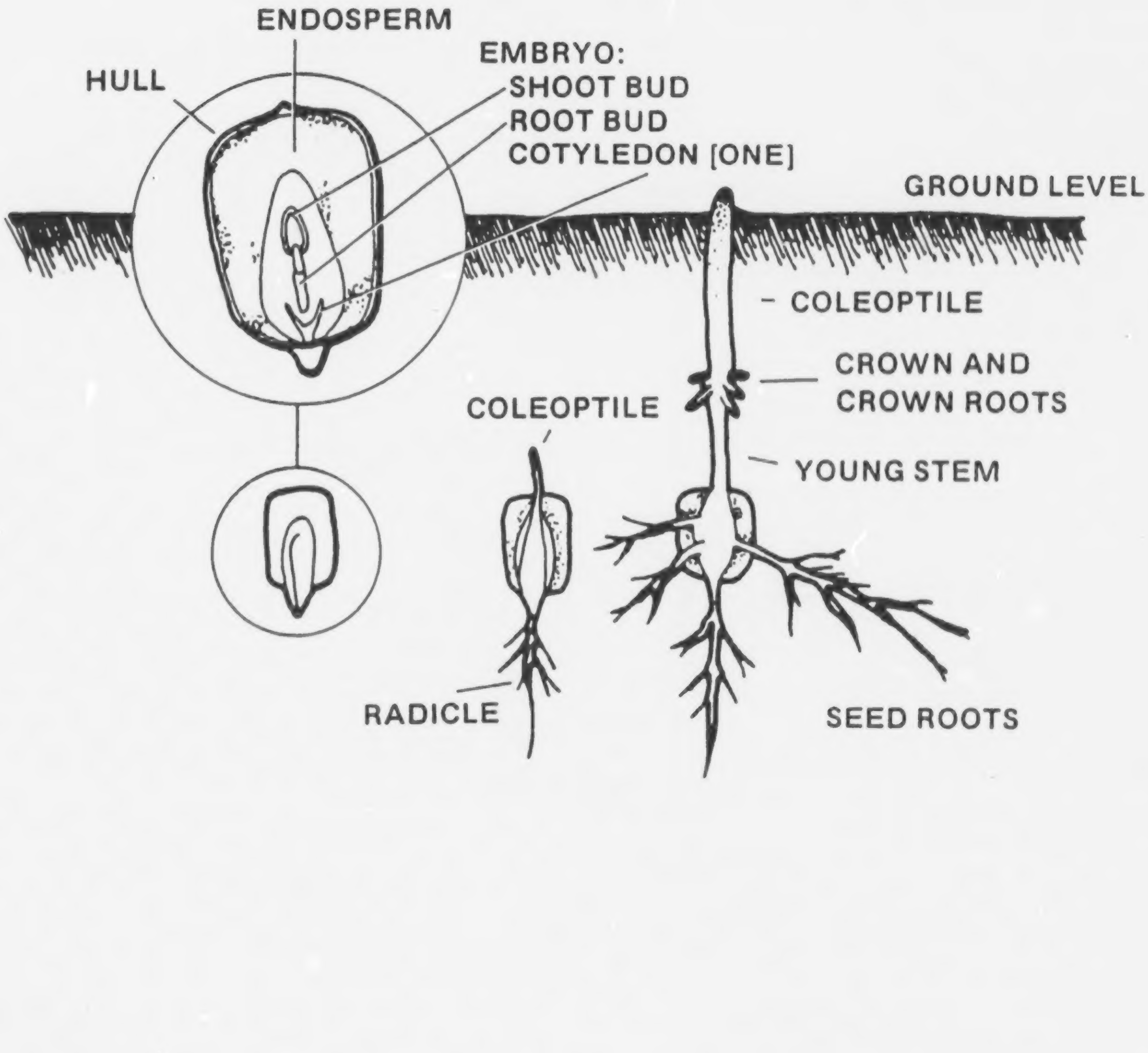
A. Moisture absorption swells seed.
B. Primary root grows downward.
C. Hypocotyl (3) grows, pushing hypocotyl arch (1) up, pulling cotyledons (2) upward. Primary root (5) continues downward with branch roots (4) forming. Root hairs (6) form on apex of each root.
D. Cotyledons (1) turn green and produce food. Hypocotyl (2) straightens out, emergence complete.
E. First internode (2) is present and elongating. Cotyledons (3) are still functioning as the first two unifoliate leaves (1) unfold. Hypocotyl (4) is now completely elongated.

Adapted from *Crop Production*, Delorit, et. al. Prentice Hall, Inc.

1104

TRANSPARENCY MASTER #12

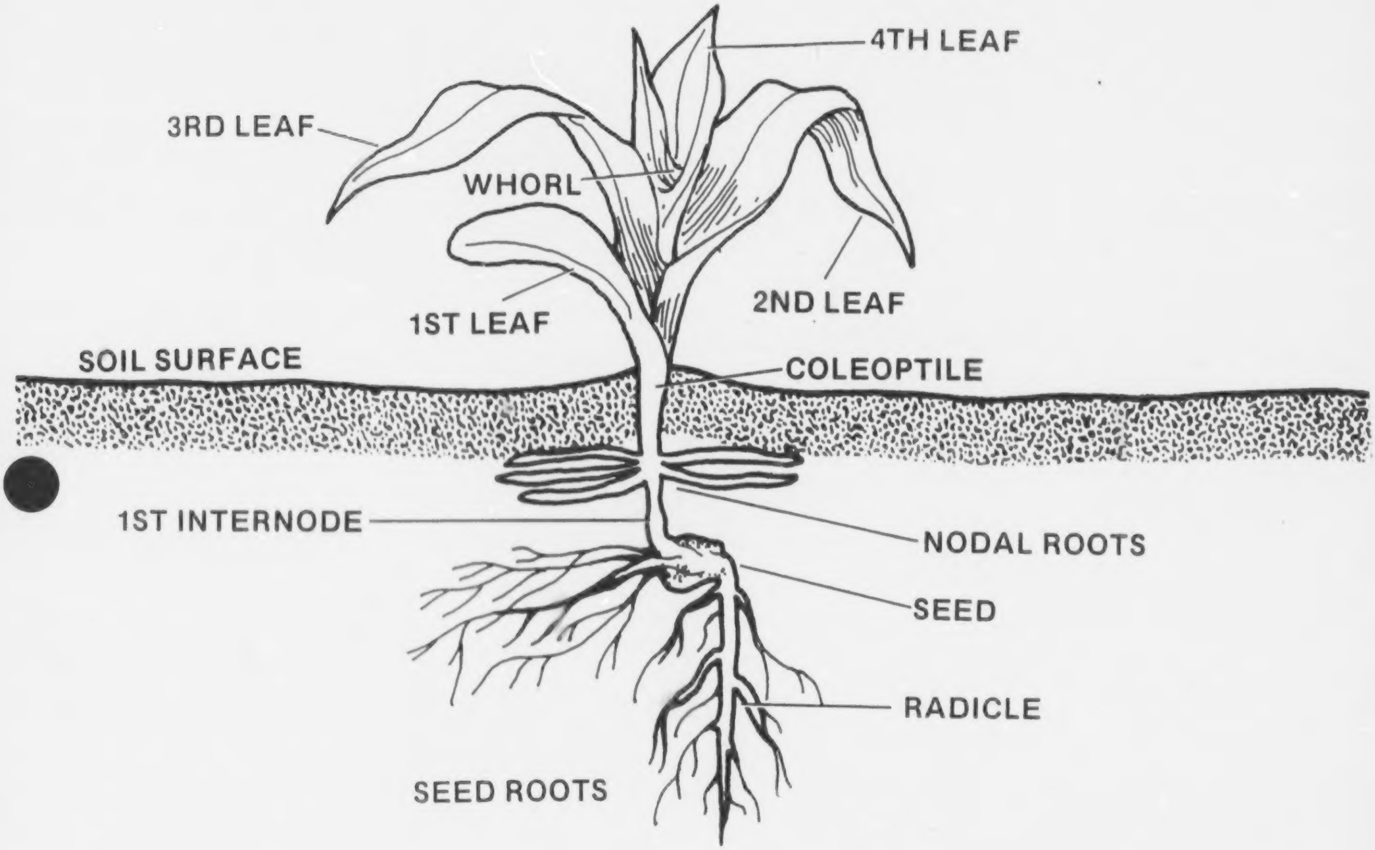
Germination of a Monocot Seed


ENDOSPERM
HULL
EMBRYO:
SHOOT BUD
ROOT BUD
COTYLEDON [ONE]
GROUND LEVEL
COLEOPTILE
CROWN AND CROWN ROOTS
COLEOPTILE
YOUNG STEM
RADICLE
SEED ROOTS

1105

TRANSPARENCY MASTER #13

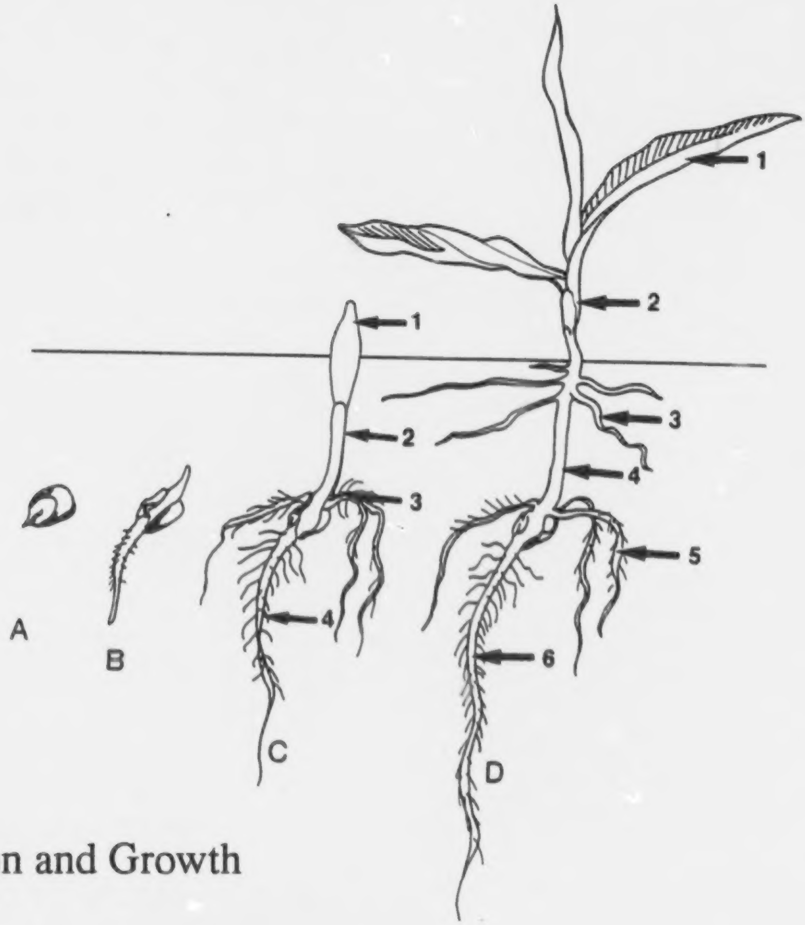
The Young Corn Plant


4TH LEAF
3RD LEAF
WHORL
1ST LEAF
2ND LEAF
SOIL SURFACE
COLEOPTILE
1ST INTERNODE
NODAL ROOTS
SEED
RADICLE
SEED ROOTS

1106

TRANSPARENCY MASTER #14

Life Cycle of a Corn Plant



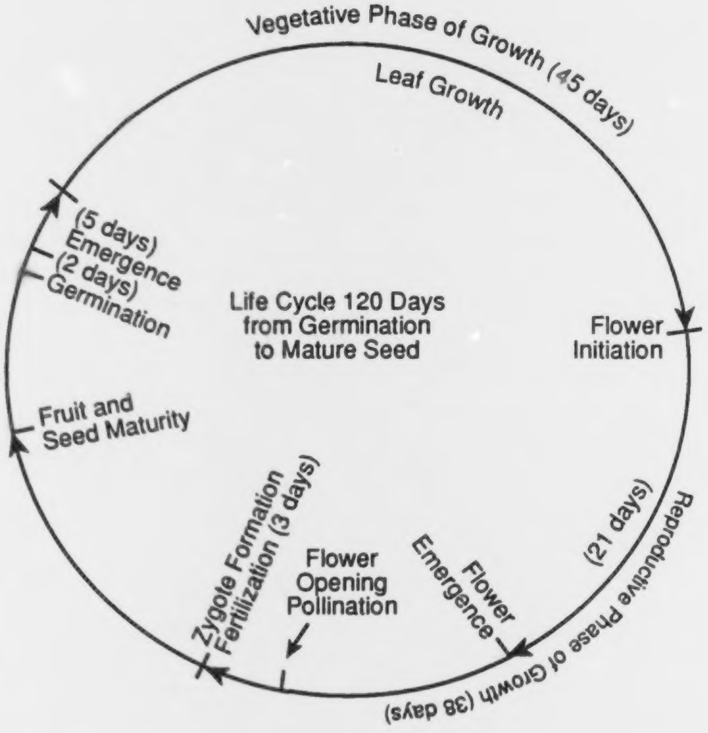
Corn Germination and Growth

A. Moisture absorption swells seed.
B. Primary root grows downward. Coleoptile emerges.
C. Coleoptile (1) and mesocotyl (2) grow up until soil surface is broken by coleoptile. Seminal roots develop from first node as primary root continues downward growth.
D. The first leaf (1) is adjacent to the remains of the coleoptile. Adventitious or nodal roots (3) form and will help support stalk. Mesocotyl (4) has lengthened and the primary root system, seminal (5) and primary (6) is present.

Adapted from *Crop Production*, Delorit, et. al. Prentice Hall, Inc.

TRANSPARENCY MASTER #15

Life Cycle from Germination to Mature Seed


Vegetative Phase of Growth (45 days)
Leaf Growth
Flower Initiation
Reproductive Phase of Growth (38 days)
(21 days)
Flower Emergence
Flower Opening Pollination
Zygote Formation Fertilization (3 days)
Fruit and Seed Maturity
Germination
(2 days)
Emergence
(5 days)
Life Cycle 120 Days from Germination to Mature Seed

Events in the life cycle of a typical annual plant — from seed planting to seed maturity — accomplished in four months. Adapted from Noggle, G.R., and G.J. Fritz. 1976. *Introductory plant physiology.* Engelwood Cliffs, N.J.: Prentice-Hall.

TRANSPARENCY MASTER #16

Vegetative Growth and Development

1. Plant Growth
2. Genetic Factors Affecting Plant Growth and Development
    - a. Structural Genes
    - b. Regulatory/Operator Genes
3. Environmental Factors Affecting Plant Growth and Development
    - a. Light
        - 1) Phototropism
        - 2) Photoperiodism
    - b. Temperature
    - c. Water
        - 1) Evapotranspiration
    - d. Gases
        - 1) CO_2
        - 2) O_2
4. Juvenility, Maturation, and Senescence
    - a. Juvenile Stage
    - b. Aging and Senescence
        - 1) Senescence

1109

TRANSPARENCY MASTER #17

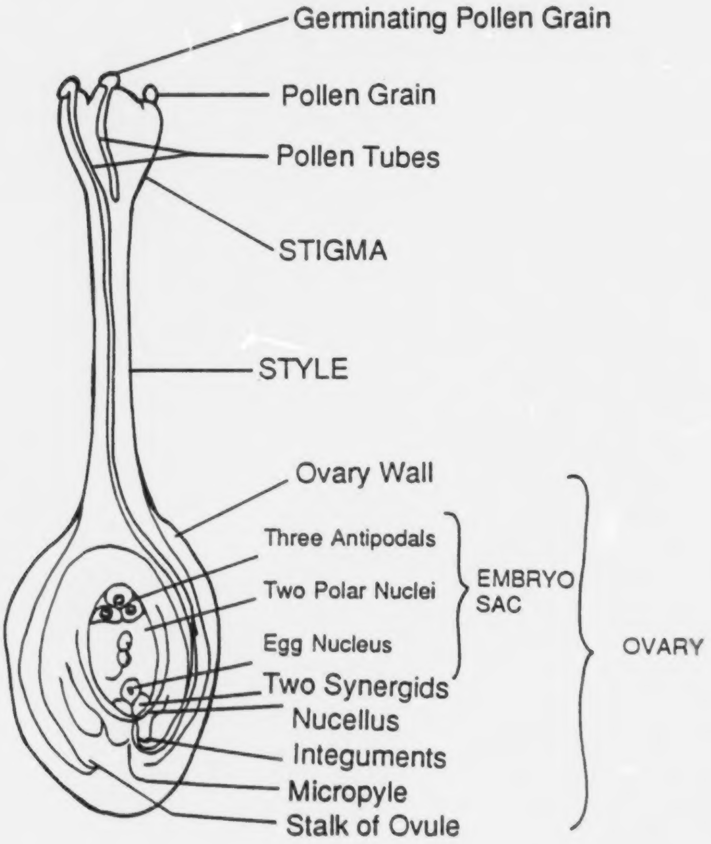
Reproductive Growth and Development

Fruit and Seed Production Involves Several Phases:

1. Flower Induction and Initiation
2. Flower Differentiation and Development
3. Pollination
4. Fertilization
5. Fruit Set and Seed Set
6. Growth and Maturation of Fruit and Seed
7. Fruit Senescence

TRANSPARENCY MASTER #18

Pistil of a Flower Following Pollination and Just Before Fertilization


Germinating Pollen Grain
Pollen Grain
Pollen Tubes
STIGMA
STYLE
Ovary Wall
Three Antipodals
Two Polar Nuclei
Egg Nucleus
EMBRYO SAC
OVARY
Two Synergids
Nucellus
Integuments
Micropyle
Stalk of Ovule

A longitudinal section through the pistil of a flower following pollination and just before fertilization.

1111

TRANSPARENCY MASTER #19

Plant Growth Regulators

There Are Five Recognized Groups of Natural Plant Hormones:

1. Auxins

2. Gibberellins

3. Cytokinins

4. Ethylene

5. Abscisic Acid

TRANSPARENCY MASTER #20

The Effects of Air Pollution on Plants

1. Extent of the Problem
2. Pollutants and Their Damage
3. Reducing Air Pollution Effects

STUDENT ACTIVITIES

STUDENT WORKSHEET #1 — Plant Germination Word Search (with solution)

STUDENT WORKSHEET #2 — The Manufacture, Use, and Storage of Food in Plants

STUDENT WORKSHEET #3 — Nutrients Required by Plants

STUDENT WORKSHEET #4 — Osmosis Laboratory and Cohesion/Adhesion Laboratory

STUDENT WORKSHEET #5 — Seed Germination Laboratory

STUDENT WORKSHEET #6 — Vegetative and Reproductive Growth and Development

STUDENT WORKSHEET #7 — Plant Growth Regulators

STUDENT WORKSHEET #8 — Effect of Soil Types on Seed Germination Laboratory

For additional activities, teachers may refer to the "Suggested Teaching Activities and Procedures" section in the Instructor's Guide.

STUDENT WORKSHEET #1

Plant Germination Word Search

E	C	Q	B	V	E	C	N	E	G	R	E	M	E	E	T	Z	F	Y	Y
A	R	T	S	E	N	Z	Y	M	E	S	R	B	R	X	S	R	Z	V	W
C	Y	U	N	M	Q	J	E	R	M	O	U	O	Q	N	C	T	R	F	G
E	Q	V	T	E	L	R	C	C	V	H	P	G	B	S	A	Q	O	X	F
M	Y	R	N	A	M	K	U	C	O	S	W	J	A	E	R	X	M	O	T
K	E	E	Y	O	R	H	Q	P	H	F	X	W	U	R	B	N	V	R	R
R	X	M	S	G	I	E	T	M	T	K	Q	X	U	X	O	A	K	P	W
J	B	U	B	W	D	T	P	W	J	U	Y	X	N	Y	N	F	I	R	M
T	I	G	H	R	E	W	P	M	O	R	R	M	B	L	D	L	U	W	K
X	N	R	G	Z	Y	L	A	R	E	R	E	E	U	V	I	Q	A	J	Y
O	O	M	O	D	E	O	L	J	O	T	G	R	I	H	O	G	I	U	A
N	I	U	D	E	W	R	V	I	D	S	O	D	C	I	X	J	W	E	Q
J	T	L	E	M	M	W	U	Z	N	O	B	R	R	G	I	S	F	P	V
I	A	U	I	D	V	W	W	T	T	G	A	A	U	L	D	Y	T	I	D
O	N	P	S	O	N	D	A	G	S	T	O	X	V	L	E	H	T	G	L
U	I	Q	E	D	S	I	R	T	S	I	U	F	V	B	G	F	K	L	I
N	M	M	E	P	Z	O	L	L	E	W	O	Z	S	I	J	C	Q	R	Q
S	R	Y	D	M	W	E	I	M	W	R	Y	M	L	E	I	X	P	B	H
G	E	B	P	T	D	S	C	L	F	V	V	J	F	M	E	Z	P	T	R
H	G	E	H	N	C	G	D	Q	F	X	K	E	O	G	L	D	A	F	P

The following words are hidden in the puzzle:

Absorption
Carbon Dioxide
Embryo
Emergence
Enzymes
Germination
Growth
Light
Moisture
Root Growth

Roots
Rupture
Seed
Soil
Spore
Starch
Sugar
Swelling of Seed
Temperature
Water

STUDENT WORKSHEET #1 — Key

Plant Germination Word Search

E	•	•	•	•	E	C	N	E	G	R	E	M	E	E	•	•	•	•	•
•	R	•	•	E	N	Z	Y	M	E	S	•	•	R	•	S	•	•	•	•
•	•	U	•	•	•	•	•	•	•	•	U	O	•	•	C	T	•	•	•
•	•	•	T	•	•	R	•	•	•	•	P	G	•	•	A	•	O	•	•
•	•	•	N	A	•	•	U	•	•	S	•	•	A	•	R	•	•	O	•
•	E	•	•	O	R	H	•	P	•	•	•	•	•	R	B	•	•	•	R
•	•	M	S	•	I	E	T	•	T	•	•	•	•	•	O	•	•	•	•
•	•	•	B	W	•	T	P	W	•	U	•	•	•	•	N	•	•	•	•
•	•	•	•	R	E	•	P	M	O	•	R	•	•	•	D	•	•	•	•
•	N	•	•	•	Y	L	•	R	E	R	•	E	•	•	I	•	•	•	•
•	O	•	•	•	E	O	L	•	O	T	G	R	•	H	O	•	•	•	•
•	I	•	•	•	•	R	•	I	•	S	O	•	C	•	X	•	•	•	•
•	T	L	•	•	•	•	U	•	N	O	B	R	•	•	I	•	•	•	•
•	A	•	I	•	•	W	•	T	T	G	A	A	•	•	D	•	T	•	•
•	N	•	S	O	•	•	A	G	S	T	O	•	•	•	E	H	•	•	•
•	I	•	E	•	S	•	R	T	S	I	•	F	•	•	G	•	•	•	•
•	M	•	E	•	•	O	•	•	E	•	O	•	S	I	•	•	•	•	•
•	R	•	D	•	W	•	•	•	•	R	•	M	L	E	•	•	•	•	•
•	E	•	•	T	•	•	•	•	•	•	•	•	•	•	E	•	•	•	•
•	G	•	H	•	•	•	•	•	•	•	•	•	•	•	•	D	•	•	•

The following words are hidden in the puzzle:

Absorption
Carbon Dioxide
Embryo
Emergence
Enzymes
Germination
Growth
Light
Moisture
Root Growth

Roots
Rupture
Seed
Soil
Spore
Starch
Sugar
Swelling of Seed
Temperature
Water

STUDENT WORKSHEET #2

The Manufacture, Use, and Storage of Food in Plants

Answer all questions. (Refer to Information Sheets)

1. Write and explain the chemical formula for respiration.
2. Define photosynthesis.
3. What are the three basic types of stored food products in plants?
4. Write and explain the chemical formula for photosynthesis.
5. List as many requirements for photosynthesis as you can.
6. What are the three net results of respiration?
7. Define respiration.
8. List and describe the two processes of photosynthesis.

STUDENT WORKSHEET #3

Nutrients Required by Plants

Match the element in the left column with its correct chemical symbol in the right column.

1. ________ Carbon Dioxide
2. ________ Molybdenum
3. ________ Manganese
4. ________ Oxygen
5. ________ Magnesium
6. ________ Hydrogen
7. ________ Iron
8. ________ Nitrogen
9. ________ Copper
10. ________ Calcium
11. ________ Potassium
12. ________ Phosphorus
13. ________ Boron
14. ________ Sulfur
15. ________ Chlorine
16. ________ Zinc

A. Mg
B. O
C. K
D. S
E. H
F. N
G. Fe
H. CO_2
I. P
J. Mn
K. Ca
L. Mo
M. Cu
N. B
O. Zn
P. Cl

STUDENT WORKSHEET #3 - Key

Nutrients Required by Plants

Match the element in the left column with its correct chemical symbol in the right column.

1.	*H*	Carbon Dioxide	A.	Mg
2.	*L*	Molybdenum	B.	O
3.	*J*	Manganese	C.	K
4.	*B*	Oxygen	D.	S
5.	*A*	Magnesium	E.	H
6.	*E*	Hydrogen	F.	N
7.	*G*	Iron	G.	Fe
8.	*F*	Nitrogen	H.	CO_2
9.	*M*	Copper	I.	P
10.	*K*	Calcium	J.	Mn
11.	*C*	Potassium	K.	Ca
12.	*I*	Phosphorus	L.	Mo
13.	*N*	Boron	M.	Cu
14.	*D*	Sulfur	N.	B
15.	*P*	Chlorine	O.	Zn
16.	*O*	Zinc	P.	Cl

STUDENT WORKSHEET #4

Osmosis Laboratory and Cohesion/Adhesion Laboratory

The process of osmosis can be demonstrated in the following manner:

1. Dissolve a tablespoonful of salt in a glass of water and then place a slice of raw potato in it.
2. After 15 to 20 minutes, an examination will show that the potato is rather soft and flabby.
3. This softness indicates that some of the water has moved from the cells of the potato where it is more concentrated into the salt solution where it is less concentrated. At the same time, but at a much slower rate because the membrane is not as permeable to salt molecules as to water molecules, salt will be moving into the cells because the concentration of salt is lower in the cells.
4. Then, place the same piece of potato in a glass of pure water.
5. The water moves back into the cells and the potato regains its firmness.
6. In this case, because no salt is present in the water, there is a greater concentration of water outside the cells and thus it moves back into them by osmosis.

The processes of cohesion and adhesion can be demonstrated in the following manner:

1. Place one end of an open-ended capillary tube into a beaker of water and observe that the water level within the capillary tube will rise to a level above that within the beaker.
2. Adhesion is the attraction between the water molecules and the inside walls of the capillary tube.
3. Cohesion is the attraction between adjacent water molecules.
4. The two types of attractive forces combine to cause the top of the water column inside the capillary tube to be held at a level above that of the water in the beaker.

STUDENT WORKSHEET #5

Seed Germination Laboratory

1. Have students work in groups of 3 - 5.
2. Supply each student with ten seeds each of corn and beans, and two "c" fold manila paper towels.
3. In one paper towel, have student group place all corn seeds. In the other, place all of the bean seeds.
4. Students should roll the paper towel and staple the ends to contain seeds inside the towel.
5. Do this process with both seed samples.
6. Using pencil (pen will run from the moisture), students should place their names or group name on the outside of the towels.
7. Students will then dampen each paper towel and place it in a tray prepared by the instructor.
8. The towels should be watered periodically over the next two to three weeks to prevent seeds from becoming dry.
9. After two or three weeks, return the seeds to the respective students.
10. Students will carefully open the towels, making certain not to destroy the germinated plants inside.
11. Students will then attempt to label all parts of the germinated seed. Each student should label one bean seed and one corn seed.
12. Have students refer back to the previous discussion on germinating bean and corn plants for the correct names of the plant parts.

STUDENT WORKSHEET #6

Vegetative and Reproductive Growth and Development

On the line to the left of each question, write the term that the phrase is describing.

1. ________________ The total soil water loss by transpiration from the plant leaves and evaporation from the soil.

2. ________________ Genes involved in protein synthesis.

3. ________________ The anther and stigma are on the same flower.

4. ________________ The anther and stigma are on different flowers on different plants of the same cultivar.

5. ________________ This is another term for the initial development of fruit after fertilization.

6. ________________ One nucleus is divided into two nuclei.

7. ________________ The movement or bending of stems, leaves, and flowers toward light.

8. ________________ Most growing plants contain about 90 percent of this.

9. ________________ Cellular and tissue breakdown and death of a plant.

10. ________________ Green plants use this for photosynthesis.

11. ________________ Green plants use this in the respiration of all plant parts.

12. ________________ The anther and stigma are on different flowers of the same plant.

13. ________________ The anther and stigma are on different flowers on plants of different cultivars.

14. ________________ The physiological responses of plants to variations of light and darkness.

15. ________________ The primary criterion for judging that a plant is in this stage is its inability to form flowers and set fruit even though all environmental conditions are conducive to flowering.

STUDENT WORKSHEET #6 — Key

Vegetative and Reproductive Growth and Development

On the line to the left of each question, write the term that the phrase is describing.

1. *Evapotranspiration* The total soil water loss by transpiration from the plant leaves and evaporation from the soil.
2. *Structural Genes* Genes involved in protein synthesis.
3. *Self-pollination* The anther and stigma are on the same flower.
4. *Self-pollination* The anther and stigma are on different flowers on different plants of the same cultivar.
5. *Fruit Setting* This is another term for the initial development of fruit after fertilization.
6. *Mitosis* One nucleus is divided into two nuclei.
7. *Phototropism* The movement or bending of stems, leaves, and flowers toward light.
8. *Water* Most growing plants contain about 90 percent of this.
9. *Senescence* Cellular and tissue breakdown and death of a plant.
10. CO_2 Green plants use this for photosynthesis.
11. O_2 Green plants use this in the respiration of all plant parts.
12. *Self-pollination* The anther and stigma are on different flowers of the same plant.
13. *Cross-pollination* The anther and stigma are on different flowers on plants of different cultivars.
14. *Photoperiodism* The physiological responses of plants to variations of light and darkness.
15. *Juvenile Stage* The primary criterion for judging that a plant is in this stage is its inability to form flowers and set fruit even though all environmental conditions are conducive to flowering.

STUDENT WORKSHEET #7

Plant Growth Regulators

As we discuss the five groups of natural plant hormones, include a description of their plant effects on this worksheet.

1. Auxins

2. Giberellins

3. Cytokinins

4. Ethylene

5. Abscisic Acid

STUDENT WORKSHEET #8

Effect of Soil Types on Seed Germination Laboratory

Purpose:

1. To learn the effect of various soil types on seed germinations.
2. To plot on graph paper the comparative results obtained among the experimental groups of seeds planted in different soils.

Materials:

1. seed packets of corn and/or beans
2. sand, silt, clay, potting soil
3. two growing flats
4. plant labels

Procedure:

1. Count out exactly 16 seeds from one of the seed packets.

2. Fill four of the 2 1/4-inch by 2 1/4-inch cells with sand, four with silt, four with clay, and four with potting soil.

3. Write your name, the date, the name of seed sown, and the specific treatment the seed will receive on a wooden plant label and place in your pot.

4. Place seeds at least one inch below the surface. Plant 1 seed per cell.

5. Once the 16 seeds are sown, water your seeds.

6. Continue to water and observe your seed cells for a total of 10 consecutive days, and make daily observations of the number of seeds that have germinated. Record this information in your notebook.

7. Prepare a graph for each seed treatment using number of seeds germinated as the Y-axis and number of days as the X-axis.

8. On graph paper, plot the daily germination rate for the four groups for the same seed.

Questions:

1. Which of the soils tested suppressed germination the most? The least?
2. Which of the seeds tested seemed to be the least affected by the differences in soils? The most affected?

Helpful Tips:

1. It may be necessary to delegate a responsible student to record the data for each of the treatments on the weekend. If impossible, all treatments should be left in a cool, low-light environment for the weekend to suppress dehydration as much as possible.
2. To assure uniformity of all soils, have each student apply the same volume of water as needed.
3. The exercise as presented suggests the use of one type of seed and four treatments to fill 16 cells. If desired, this exercise can be expanded to include other seeds.

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Controlling Plant Pests

RELATED PROBLEM AREA(S):

1. Identifying Basic Principles of Plant Science (Central Core Cluster)
2. Controlling Plant Pests (Horticulture Cluster)

PREREQUISITE PROBLEM AREA(S):

1. Identifying Basic Principles of Plant Science (Central Core Cluster)

LEVEL: Preparatory

OCCUPATIONAL TASKS ADDRESSED:

Agricultural Business and Management Cluster

Duty J: Applying Fertilizers and Chemicals

1. Evaluate chemicals applied to test plots
2. Dispose of chemicals and containers according to manufacturer's specifications
3. Prepare chemical program
4. Calculate application rates
5. Calculate proportions of chemical and carrying agents
6. Map chemical applications
7. Compute chemical costs
8. Time fertilizer and chemical applications
9. Maintain chemical files

Duty L: Growing Corn, Soybeans, Small Grains, or Forage Crops

1. Select pest control program
2. Spray crop for pest control
3. Cultivate crop

Duty P: Scouting Fields for Weed, Disease, Insect, or Other Damage

1. Scout fields for weeds
2. Identify plant diseases
3. Identify crop insects and pests
4. Identify visually herbicide injury of plants
5. Identify visually injury of plants due to herbicide residues in the soil
6. Make recommendations for fungus control
7. Make recommendations for insect control
8. Make recommendations for weed control
9. Make recommendations for disease control

STATE GOALS FOR LEARNING:

In planning the instruction for this problem area, teachers can promote the development of several student learning objectives which are related to the State Goals for Learning in Biological and Physical Sciences. These objectives are listed on the Learning Assessment Plan forms included on the following page(s). Those learning objectives marked with an asterisk (*) are taken from the sample lists provided by the Illinois State Board of Education.

Illinois Agricultural Core Curriculum
Agricultural Education 124 Mumford Hall 1301 W. Gregory Drive University of Illinois Urbana, IL 61801

Director: Dale A. Law, Ed.D.
Principal Investigator: Jerry D. Pepple, Ed.D.
Research Assistant: Randy J. Bernhardt

Illinois Agricultural Core Curriculum Rev.

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date ____________________
☐ Original submission ☐ Revision
Page ____ of ____

I. LEARNING AREA *(check one)*
☐ Language Arts
☐ Mathematics
☒ Sciences
☐ Fine Arts
☐ Social Sciences
☐ Physical Development/Health

(Affix label or complete district information.)

COUNTY	DISTRICT	ESC

District Name

City

Contact Person: ____________________
Title: ____________________
Phone: (   )

II. STATE GOAL FOR LEARNING
As a result of their schooling, students will have a working knowledge of the concepts and basic vocabulary of biological, physical, and environmental sciences and their application to life and work in contemporary technological society.

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Understand the principle of cause and effect as it applies to disease.					
2. Understand how weeds are harmful.					
3. Understand how insects are harmful to plants.					

Controlling Plant Pests

Agricultural Business and Management
Plant and Soil Science

ISBE 41-78 (1/88)

Submission Date ____________________
☐ Original submission ☐ Revision
Page ____ of ____

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☒ Sciences ☐ Physical Development/Health

ILLINOIS STATE BOARD OF EDUCATION
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LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)
COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐
District Name
City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will have a working knowledge of the principles of scientific research and their application in simple research projects.

Contact Person: ____________________
Title: ____________________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Demonstrate alternative procedures for solving a problem.					
2. Develop an understanding of weed control principles by mechanical, biological, and chemical methods.					
3. Understand how to control insects that harm valuable plants.					
4. Understand how to control diseases that harm valuable plants.					
5. Handle pesticides safely and obtain pesticide license.					
1130					1131

ISBE 41-78 (1/88)

Illinois Agricultural Core Curriculum Rev.

Controlling Plant Pests

Agricultural Business and Management
Plant and Soil Science

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Controlling Plant Pests

STUDENT LEARNING OBJECTIVES

Upon completion of their study of this problem area, students will be able to:

1. Understand how to control diseases that harm valuable plants.
2. Understand how weeds are harmful.
3. Develop an understanding of weed control principles by mechanical, biological, and chemical methods.
4. Understand how insects are harmful to plants.
5. Understand how to control insects that harm valuable plants.
6. Handle pesticides safely and obtain a pesticide license.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Controlling Plant Pests

PROBLEMS AND QUESTIONS FOR STUDY	INSTRUCTOR'S NOTES AND REFERENCES
1. What diseases commonly affect plants?	
2. What symptoms will identify the disease?	
3. How can plant diseases be controlled?	
4. In what ways are weeds harmful to valuable plants?	
5. What is meant by mechanical control of weeds?	
6. What does biological weed control mean?	
7. How can weeds be controlled chemically?	
8. How can insects be harmful to plants?	
9. How can harmful insects be controlled?	
10. Demonstrate methods of handling pesticides safely.	
11. What is a pesticide license? Why is it needed?	

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Controlling Plant Pests

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES

1. As an interest approach to the problem area, ask the questions, Why is it important to learn about diseases, insects, and weeds in a plant science course? What are the problems that these pests can cause? How do we control such pests?

2. In answer to the question, What do plants look like if they have had either herbicide injury or disease injury?, explain common injuries due to diseases and herbicides and the causes of these injuries. To supplement this topic, use VAS materials listed in item 3 of the references.

3. Involve class in a discussion on controlling diseases in crop plants.

4. Conduct a discussion with the class on the harm weeds can do to crop plants. You may also want to discuss some of the ways weeds are beneficial, for example:

   a. On bare soils, weeds retain soil moisture and prevent nutrient loss from erosion and leaching.
   b. Weeds provide a source of organic matter.
   c. Quackgrass can provide feed for animals in the absence of good pasture or hay.
   d. Weeds provide shelter and feed for birds, wild game, and other animals.
   e. Some weeds have values for medicinal purposes.
   f. Some weeds have ornamental value for horticulturalists and interior designers.

   Use VAS Transparency *How Herbicides Work* to assist in the discussion of weeds. (See item 4 in references.)

5. Have students conduct a weed collection of 15-20 common weeds. Have them identify the weeds by the common name and the scientific name.

6. Ask students the following questions: What is meant by mechanical control of weeds? What does biological weed control mean? How can we control weeds with chemicals? Refer to Transparency Masters on this topic. Use Student Worksheet #1 to introduce this subject. Have students complete Student Worksheet #2.

7. Conduct a discussion with students on the harmful effects and control of insects. Refer to Information Sheets and Transparency Master.

8. Ask students, "Why is it necessary to have a pesticide license?" Use this interest approach to begin discussion on pesticides, pesticide use, pesticide safety, and pesticide licensing.

9. Have students complete Student Worksheet #3. The assignment is to be completed with an example label from VAS Unit *Handling and Safe Use of Pesticides*. (See item 5 in references.)

10. Additional VAS materials will prove beneficial in the instruction of this problem area. See item 5 in references.

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Controlling Plant Pests

REFERENCES

1. *Producing Farm Crops*. (1981). Boone, Richer, Wilson. Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

*2. *Crop Production*. (1984). Delorit, Greub, Ahlgren. 5th edition. Prentice-Hall, Inc., 200 Old Tappan Road, Old Tappan, NJ 07675. (800) 223-2348.

*3. *Diseases of Alfalfa* (VAS Slidefilm #F749); *Diseases of Clover* (VAS Slidefilm #F750); *Diseases of Wheat* (VAS Slidefilm #F773); *Soybean Disease Management* (VAS Slide Set #S756); *Corn Problem Series* (VAS Filmstrip Set #MF732-l); *Corn Problem Series* (VAS Slide Set Series #MS732-l); *Field Crop Plant Diseases, Herbicide Injury, and Insects* (VAS Spiral Bound Booklet #MX799.91). Vocational Agriculture Service, College of Agriculture, University of Illinois, 1401 S. Maryland Drive, Urbana, IL 61801. (217) 333-3871.

*4. *How Herbicides Work* (VAS Transparency #T700). Vocational Agriculture Service, College of Agriculture, University of Illinois, 1401 S. Maryland Drive, Urbana, IL 61801. (217) 333-3871.

*5. *Handling and Safe Use of Pesticides* (VAS Unit #U4045A); *Understanding and Safe Use of Pesticides* (VAS Slidefilm #F1108); *Selecting and Handling Pesticides* (VAS Slidefilm #F1108-1.2); *Safe Use of Pesticides Around the Home* (VAS Slidefilm #F1108-2.1); *The Pesticide Review Process* (VAS Slidefilm #F1108-3.1); *Safe Use of Pesticides* (VAS Transparency #T790). Vocational Agriculture Service, College of Agriculture, University of Illinois, 1401 S. Maryland Drive, Urbana, IL 61801. (217) 333-3871.

6. *Plant Science: Growth, Development, and Utilization of Cultivated Plants*. (1981). Hartmann, Flocker, Kofranek. Prentice-Hall, Inc., 200 Old Tappan Road, Old Tappan, NJ 07675. (800) 223-2348.

*Indicates highly recommended reference

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTIONAL RESOURCES

These resources are intended for use by teachers in planning and teaching the materials for this problem area and may be adapted to fit the teaching method(s) used.

INFORMATION SHEET #1 — Control of Plant Diseases

INFORMATION SHEET #2 — Weeds are Harmful in Many Ways

INFORMATION SHEET #3 — Mechanical Control of Weeds

INFORMATION SHEET #4 — Biological Control of Weeds

INFORMATION SHEET #5 — Chemical Control of Weeds

INFORMATION SHEET #6 — How Insects are Harmful to Plants and Their Control

INFORMATION SHEET #7 — Terms to be Defined

INFORMATION SHEET #8 — Items Pesticide Applicators and Operators are Expected to Know for Certification

INFORMATION SHEET #9 — How and Why to Be Certified as a Private Pesticide Applicator

INFORMATION SHEET #10 — Advantages and Disadvantages of Application Equipment

INFORMATION SHEET #11 — Poisoning Symptoms and First Aid Treatments

INFORMATION SHEET #12 — Passing Certification Tests

TRANSPARENCY MASTER #1 — Weeds are Harmful in Many Ways

TRANSPARENCY MASTER #2 — Mechanical Control of Weeds

TRANSPARENCY MASTER #3 — Biological Control of Weeds

TRANSPARENCY MASTER #4 — Chemical Control of Weeds

TRANSPARENCY MASTER #5 — How Insects are Harmful to Plants and Their Control

TRANSPARENCY MASTER #6 — Key Pesticide Indicators

TRANSPARENCY MASTER #7 — Methods of Pesticide Poisoning

TRANSPARENCY MASTER #8 — Recommended Protective Clothing and Equipment

TRANSPARENCY MASTER #9 — Safest Method of Disposal of Highly Toxic Containers

TRANSPARENCY MASTER #10 — Other Methods of Disposal of Highly Toxic Containers

TRANSPARENCY MASTER #11 — Other Methods of Disposal of Highly Toxic Containers

TRANSPARENCY MASTER #12 — Recommended Storage of Pesticides

INFORMATION SHEET #1

Control of Plant Diseases

Corn

Corn Smut — Rotation of crops and clean plowing are helpful in controlling smut. Cutting and destroying the infected stalks also aids in reducing damage where infections are not too severe. Plant breeders have developed strains that have moderate resistance.

Giberella (seedling blight; stalk, ear, and kernel rots) — Clean plowing of corn fields and crop rotation are helpful if practiced over a wide area. Applications of potassium appear to reduce giberella. There are resistant hybrids and a seed treatment with a fungicide.

Fusarium (kernel or ear rots) — There is no specific control. There is a difference in resistance among cultivars.

Diplodia (seedling blight, stalk rot, and ear rot) — Resistant hybrids provide most effective control. There is a fungicide treatment of seed.

Nigrospora Cob Rot — Select adapted, full season cultivars. Use proper fertilization practices.

Charcoal Rot — Attempts are being made to develop a satisfactory level of resistance to disease in cultivars.

Northern Leaf Blight — Use resistant hybrids. Fungicides are effective in controlling the disease, but must be applied at intervals of 5-7 days. Plants grown in soils high in potassium suffer less from the disease.

Southern Leaf Blight — Only means of control is the use of hybrids with disease resistance.

Bacterial Wilt — Use of resistant cultivars is the only practical control method.

Maize Dwarf Mosaic — Destruction of Johnsongrass tends to reduce severity of infection. Use of resistant hybrids is the only means of satisfactory control.

Soybeans

Bacterial Blight — Avoid highly susceptible cultivars. Plant seed free of the organism. Fall plowing to bury crop residues is helpful.

Bacterial Pustule — Use resistant cultivars.

Anthracnose — Plant seed known to be disease-free or treat seed with a fungicide. Completely plow under soybean crop residues and rotate soybeans with other crops.

Brown Stem Rot — Use crop rotation. Red clover may harbor the organism and should not be prior to soybeans in a crop rotation. Plant breeders are attempting to develop resistant cultivars.

Brown Spot or Septoria Leaf Spot — Use most resistant cultivars available. Plant only seed known to be free of the organism. Clean plowing of soybean residue and rotation with other crops is helpful. Application of foliar-applied fungicide between bloom and pod-fill may prove helpful.

Powdery Mildew — Use resistant cultivars. Apply approved foliar fungicide.

Phytophthora Rot — Use of resistant cultivars is the only satisfactory control.

Stem Canker — Use crop rotation and plow plant residue under. Grow most resistant cultivars.

Purple Seed Stain and Cercospora Leaf Spot and Blight — Use high quality seed and resistant cultivars.

Bud Blight — The virus has many other hosts including common broadleaved weeds, weeds such as lambsquarters, pigweed, and velvetleaf, and legumes such as clover and alfalfa. Recommended practice is to plant at least four rows of a tall-growing nonsusceptible crop such as corn or forage sorghum between the soybeans and a legume crop or noncultivated areas. Early spring use of herbicides to control broadleaved weeds in noncultivated areas adjacent to soybean fields is also recommended.

Wheat

Stinking Smut or Bunt — Use crop rotation. Use resistant cultivars or treat with a fungicide.

Loose Smut — Use systemic fungicides and resistant cultivars.

Black Stem Rust — Practice early planting or use cultivars that escape damage because of early maturity. Most effective prevention is the use of disease-resistant cultivars. Fungicide sprays are effective in controlling the disease if properly timed.

Leaf Rust — Use resistant cultivars. Losses can be reduced by early planting or using cultivars that escape damage because of early maturity.

Wheat Scab — Crop rotation, clean tillage, and seed treatment are partially effective.

Powdery Mildew — Use resistant cultivars.

Streak Mosaic — Volunteer plants in field to be seeded should be destroyed three weeks before planting and those in adjacent fields one week prior to planting. Use cultivars resistant to the virus. Late-sown winter wheat generally escapes heavy infestation.

Septoria Blotch — Seed treatment, crop rotation, and destroying volunteer wheat plants assist in control.

Oats

Smut — Treat with recommended seed disinfectants. Use resistant cultivars.

Stem Rust — Eradication of common barberry, the alternate host, is helpful in reducing infestation. Use early-maturing cultivars and resistant cultivars.

Crown Rust — Eradication of buckthorn, an alternate host, controls early infection. Use resistant cultivars.

Yellow Dwarf — Use good cultural practices and early planting. Best control is the use of tolerant cultivars.

Septoria Foliage Blight — Plow under old straw and stubble. Rotate crops. Use resistant cultivars.

Barley

Brown Smut — Only fungicide that is effective is carboxin. Use resistant cultivars.

Black Smut — Several fungicides are effective. Use resistant cultivars.

Covered Smut — Use resistant cultivars and fungicides.

Spot Blotch — Seed treatment, crop rotation, and sanitation practices such as plowing under cereal crop residues are helpful. Use resistant cultivars.

Net Blotch — See Spot Blotch control methods.

Scab — Use seed treatment with a fungicide. Use clean plowing of residue in the fall and crop rotations in which barley doesn't follow itself.

Barley Yellow Dwarf — Use tolerant cultivars.

Barley Stripe — Use seed treatment and resistant cultivars.

Rye

Ergot — Crop rotation, sowing disease-free seed, and cutting or destroying volunteer plants of rye, weed grasses, or susceptible forage grasses are helpful.

INFORMATION SHEET #2

Weeds are Harmful in Many Ways

1. Reduction in Yields — Weeds use soil moisture that would otherwise be available for crop plants. Weeds grow more rapidly and mature sooner than crop plants. Thus they deplete the moisture supply of the soil in advance of the time when slower growing crops need moisture most. Weeds also compete for soil nutrients. Some weeds obtain water and food directly from crop plants rather than from the soil. These are called parasitic plants. Crop plants are often greatly retarded by shading caused by weeds. A number of weeds also produce growth-inhibiting substances that retard and reduce crop plant growth.

2. Reduced Quality of Products from Plants and Animals — Heavy infestations of certain weeds and their seeds reduce crop value. Certain weeds produce strong tastes and odors. Others cannot be separated from crop seed. Some, if consumed by animals, will change the flavor of the by-product.

3. Menace to Livestock and People — Some weeds are poisonous. Some can cause massive deaths in a herd of animals. Hay fever in humans is usually caused by an allergy to some type of weed pollen. Some are poisonous by consumption; others may be poisonous only through direct contact.

4. Losses from Disease and Insects Harbored by Weeds — Some weeds spread harmful insects and diseases. Many times the insects and/or diseases migrate from weeds to valuable crop plants. Some weeds serve as alternative hosts for certain diseases. Then they are transferred from weeds to valuable crop plants.

5. Increase of Production Costs — Greater effort and expenses are needed to control or destroy weeds. Extra tillage, spray equipment, added fuel cost, herbicides, and labor all add to increased overall production costs.

6. Reduction of Land Values — People hesitate to purchase land infested with weeds. Extent of price value reduction depends upon type of weeds present and degree of infestation.

INFORMATION SHEET #3

Mechanical Control of Weeds

1. Cultivation — The best time to destroy all types of weeds by cultivation is when they are young and not well established. Many are destroyed during seedbed preparation by the use of such equipment as the disk harrow, spring-tooth harrow, field cultivator, and rotary tiller. The weed seedlings are brought to the surface where they dry up and die. After row crops are well established, a row crop cultivator should be used to control weeds. The main purpose of cultivating row crops is to control weeds.

2. Mowing — Where feasible, mowing at well-timed intervals is effective to control weeds. Mowing of annuals and second year biennials early enough to prevent seed production will result in their eventual elimination.

3. Crop Rotation — When the same crop is grown year after year on the same field, a build-up of certain weeds takes place. Crop rotation reduces the weed population and prevents the increase of certain weed species.

INFORMATION SHEET #4

Biological Control of Weeds

1. Description — Biological control involves introduction of a natural enemy which weakens or destroys a particular weed. These natural or biological predators may be insects, microorganisms, parasitic plants, animals, birds, and fish. Most success achieved in biological control involves the use of insects.

2. Advantages —
    a. More economical than either mechanical or chemical control.
    b. Free of the residue problems which are associated with herbicides.
    c. Longer lasting in effect than other methods.
    d. Free from fossil fuel energy requirements.

3. Limitations —
    a. Not well suited to croplands because it usually doesn't respond rapidly enough.
    b. Not effective in reducing weed population to an acceptable level for some crops to produce well.
    c. Not effective on a stand of mixed weed species.
    d. Not adapted for use on weeds that are closely related to crop plants.

4. Overall Goal — The goal of biological control is not total eradication but reduction of the weed population to an acceptable level.

INFORMATION SHEET #5

Chemical Control of Weeds

1. Introduction

Since 1944, many new chemicals have been developed that kill or inhibit growth of certain weeds but don't harm crops. Such chemicals are called selective herbicides and are the most commonly used herbicides. Chemicals that kill all plants are known as nonselective herbicides.

2. Types of Treatment

   a. Broadcast — application that covers the entire area in a uniform rate.
   b. Row or band treatment — application of a band of chemical directly over the row. This provides for chemical weed control within the crop row.
   c. Spot treatment — application used on limited areas that are infested with weeds.
   d. Directed sprays — application of a directed spray in a manner that avoids damage to crop but results in satisfactory weed control, as in the following examples.
      1) Direct spray above the soybeans, but low enough to come in contact with upper part of taller weeds.
      2) Use nozzles to apply spray below corn leaves where absorption is minimal and avoids the injury that would result if it were applied over top of corn.

3. Time of Treatment

   a. Preplant — treatments made before the crop is planted.
   b. Preemergence — treatments made before either the crop, the weeds, or both emerge from the soil.
   c. Postemergence — treatments made after the crop, the weeds, or both have emerged.

4. Herbicide Types

   a. Contact herbicide — kills plants by direct injury to the cells; effective only when applied postemergence.
   b. Systemic herbicide — kills by interfering with the physiological and metabolic processes of plants; absorbed by the plants and produces toxicity in the plants. Most of the herbicides currently used are in this group.

5. Physiological Factors

   a. Translocation — For most herbicides to be effective, they must move from the point of absorption to the site in the plant where toxic activity takes place.
   b. Inactivation and activation
      1) Some tolerant species absorb large amounts of herbicide but are able to "neutralize" its toxic ability. The absorbed herbicide reacts with chemicals in plant cells and forms an insoluble and untranslocatable compound.
      2) Chemical reactions within a plant's cells may change a nontranslocatable compound to a translocatable form and promote its effectiveness.
      3) Some plants can inactivate a herbicide by accumulating and storing it in cavities where it isn't toxic to the plant.
      4) Certain plants can protect against a herbicide by getting rid of it before it accumulates to a toxic level.

6. Metabolic Factors

Metabolism includes numerous biochemical processes in the plant cells by which living matter is built up and broken down into simple compounds. Herbicides generally destroy plants by interrupting or disrupting one or more of these processes.

INFORMATION SHEET #6

How Insects Are Harmful to Plants and Their Control

Corn

Pest	*Harmful Effects*	*Control*
European Corn Borer	Moths lay their eggs on under part of leaves and also on the stalk. The young larvae enter the stalk near the top and work their way downward, feeding as they go. When reaching a node or joint, they usually emerge and reenter the stalk just below the joint. Shank and ear may be damaged, and tassels or stalks may be broken off.	Use proper cultural methods, resistant or tolerant hybrids, insecticides, and biological methods. Natural enemies of this pest include birds, diseases, and certain insects.
Southern Cornstalk Borer and Southwestern Corn Borer	The life cycle of and injuries caused by these two insects are similar. Larvae feed on unfolding leaves or may enter the stalk. Greatest injury is to the stalks. Larvae, upon maturity, migrate to the second or third node, form a chamber, and pupate. This will girdle the rind of the stalk.	Plow under corn stubble. Practice crop rotation. Late planting is also helpful in their control. Use well-adapted, vigorous hybrids.
Chinch Bug	Young nymphs suck the sap from the plants. The insects feed by piercing plant tissue and sucking juices from the phloem. It is believed that this feeding process clogs the phloem causing infested plants to wilt, turn yellow, and die.	For prevention of serious infestations, destroy existing insects. Resistant crops such as soybeans, clovers, and alfalfa will aid in reducing the number of insects. Use contact insecticides.
Corn Ear Worm	Larvae feed on the silks and migrate into the ear.	Plow in late fall. Insecticides are effective but are usually not practical for field corn.
Corn Rootworms	Northern and Western Rootworm — The larvae feed on the corn roots, and in heavy infestations the root damage is so severe that the corn plant falls over. Adults emerge in the summer and feed on the silks and pollen.	Practice crop rotation. Use insecticides.
	Southern Rootworm — Larvae feed on young roots of corn plant, burrow into larger roots, and sometimes eat out the crowns of the young plants. Adults feed on leaves and silks after emerging from the soil.	Cultivate before late planting.
Corn Root Aphid	It obtains its nourishment by sucking juices from the roots. It usually attacks young plants. Infected plants are yellow in color, wilt more readily than other plants, and don't make a normal growth.	Use crop rotations and proper cultural practices. Destroy nests by deep plowing. Insecticide may be necessary for severe infestations.

Wheat

Pest	*Harmful Effects*	*Control*
Hessian Fly	Maggots burrow into sheaths of leaves of young plants and feed upon the juices, weakening the plants and frequently causing lodging.	Plant winter wheat so that it emerges after flies have died. Use sound cultural practices, including plowing under stubble, prompt destruction of volunteer wheat growth, and sowing of high-quality seed. Promote rapid growth by proper fertilization and seedbed preparation. Use resistant cultivars.
Wheat Jointworm	Larvae suck juices from the plants. Stems are weakened and frequently lodge.	Practice crop rotation. Keep soil in good state of fertility. Plow under stubble immediately after harvest.
Wheat Strawworm	Young larvae feed on the stems, destroying each tiller that they attack; at times entire plant is killed. If larvae attack when wheat is heading, the plant weakens to the extent that the kernels do not develop normally.	Practice crop rotation and grow wheat no closer than 60 yards from old straw and stubble. Destroy volunteer wheat plants. Use deep plowing if planting winter wheat.
Wheat Stem Sawfly	Adult slits stem of wheat plant about time of heading and deposits eggs inside the stem. Larvae feed inside the stem, working their way toward the base. As a result, plants usually lodge and yield is reduced.	Insecticides do not work since most of insect's life is spent inside the wheat stem. Crop rotation, prompt harvesting when wheat is mature, and deep lowing in spring will reduce losses due to this insect.
Greenbug	Bugs suck the juices of the plants and when present in large numbers kill them. Damage first appears as spots of dead wheat, which have a scorched look. As feeding continues, infected areas become larger and eventually an entire field may be killed.	Destroy volunteer wheat, oats, and barley plants. Ladybird beetles, lacewing flies, and several other insects feed on and help control greenbugs biologically. Insecticides are effective.
Chinch Bug	Refer to Corn for Harmful Effects and Control.	
Grasshoppers	Grasshoppers cause serious injury to wheat and other crops, especially during dry seasons. The young feed on foliage. Adults continue feeding and migrating until killed by cold weather.	Insecticides provide most effective control.

Soybeans

Pest	*Harmful Effects*	*Control*
Bean Leaf Beetle	During the larval or worm stage, the insect feeds on roots; later it feeds on the leaves.	Apply insecticide to the foliage.

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Mexican Bean Beetle	Both larvae and adults feed on leaves, but most of the damage is caused by larvae. Adults may eat holes in bean pods.	Treat seedling beans with an insecticide if adult beetles are found on most plants. For greatest effectiveness, spray must reach underside of soybean leaves.
Velvetbean Caterpillar	Larvae eat the leaves, buds, and tender stems of the plant, beginning at the top and working down. They are capable of stripping the plant in a short time period.	Apply recommended insecticide to foliage.

Alfalfa

Pest	*Harmful Effects*	*Control*
Alfalfa Weevil	Larvae feed on the shoot tips and upper leaves, then move downward on the plants, leaving only the framework of the leaves behind them.	Harvest early . Insecticides are necessary for heavy infestations. The alfalfa weevil has a natural enemy, a parasitic wasp from Europe.
Potato Leafhopper	Under favorable conditions, leafhoppers are usually present in large numbers and injure plants by sucking sap from the leaves and stems. Infected plants are stunted and many leaves turn yellow and drop off.	Delaying first cutting for ten days reduces leafhoppers in the second cutting crop. Insecticides are effective. Use resistant cultivars.
Lygus Bug	Lygus bugs injure both foliage and flowers by inserting their beaks into the flowers, buds, stems, and seeds, and sucking sap from the plant.	Apply an approved insecticide.
Alfalfa Aphid	Both old and young insects suck sap from leaves and young alfalfa stems causing foliage to turn yellow and wilt. Severe infestations will cause the tops to die.	Lady beetles and certain parasitic wasps (all common in nature) are among the most numerous and beneficial enemies. Chemical control is effective also.
Spotted Alfalfa Aphid	Insect sucks the juices from both leaves and stalks of plant and, at same time, injects a toxic substance that causes leaves to curl, turn yellow, and drop off.	Natural enemies (lady beetles, damsel bugs, and lacewing flies) of the aphid exist. Insecticides are effective. Resistant cultivars are available.
Meadow Spittlebug	Nymphs suck the juices from the plant causing shortening of internodes and general stunting of the plant.	For large populations of the insect, use an approved insecticide. Late fall or early spring plowing of any crop that harbors the eggs will eliminate damage to a new seedling by the nymph.

INFORMATION SHEET #7

Terms to be Defined

Absorb — to take a pesticide or other material into a plant, animal, or the soil.

Acute poisoning — poisoning which occurs after a single exposure to a pesticide.

Agricultural commodity — any plant or plant part, animal, or animal product produced by a person.

Antidote — treatment given by a medically trained person to reduce the effects of pesticide poisoning.

Application — process of directing or placing pesticides on or in plants, animals, buildings, soil, air, water, or other places.

Broad spectrum (nonselective) — pesticide which is toxic to a wide range of pests; used when several different pests are a problem. (Note: short term, residual, and broad spectrum are often used in describing insecticides and miticides.)

Cannister — metal or plastic container filled with absorbent materials to filter fumes and vapors from the air.

Cartridge — cylinder-shaped part of the respirator which absorbs fumes and vapors from the air.

Certification — recognition by certifying agency that a person is competent and thus authorized to use or supervise the use of restricted-use pesticides.

Chronic poisoning — poisoning which occurs as a result of repeated exposures to pesticides over a period of time.

Contact — to touch or be touched by.

Contact poison — pesticide which kills when it touches or is touched by the pest.

Contaminate — pollute or make unfit for use.

Dermal toxicity — level of poisonous effect a pesticide has to man or animal when in contact with the skin.

Diluent — liquid, such as water, kerosene, alcohol, or dust, which dilutes or weakens a concentrated pesticide.

Dilute — to make a pesticide thinner or weaker by adding water, oil, or other material.

Disposal — act or process of correctly discarding pesticides and pesticide containers by sealing them in sturdy, waterproof, chemical-proof containers which are then sealed in thick plastic, steel, or concrete to resist damage or breakage.

Dose, dosage — portion or amount of pesticide mixture which is directed at the target.

Downwind — direction toward which the prevailing wind is blowing

Drift — movement by wind and wind currents of droplets or particles of a pesticide.

Encapsulation — method of disposal of pesticides or pesticide containers by sealing them in sturdy, waterproof, chemical-proof containers which are then sealed in thick plastic, steel, or concrete to resist damage or breakage. (Note: The whole package is then usually buried in an area where water could not be contaminated even if leakage occurs.)

Environment — surroundings, usually water, air, soil, plants, and animals.

EPA — United States Environmental Protection Agency.

Exposure — not protected or shielded; contact with pesticides through mouth, lungs, or skin.

Face shield — piece of protective equipment used by a pesticide applicator to protect face from exposure.

First aid — first effort to help a victim of poisoning while medical help is on the way.

Fume — unpleasant or irritating smoke, vapor, or gas.

Fumigant poison — pesticide which enters the pest in the form of a gas and kills it.

Hazard — risk of danger; chance that injury or harm will come to the applicator, other persons, plants, or animals.

Herbicide — pesticide that is used to control unwanted plants.

Incinerator — special high-heat furnace or burner which reduces everything to nontoxic ash and gas.

Inhalation — to take air into the lungs; to breathe in.

Inhalation toxicity — level of poisonous effect a pesticide has to man or animal when breathed in through the lungs.

LC$_{50}$ — concentration of a pesticide in the air which would kill half of a large number of test animals exposed to it. (Note: The lower the LC number value, the more poisonous the pesticide. It is often used as the measure of acute inhalation toxicity. LC stands for lethal concentration.)

LD$_{50}$ — dose or amount of a pesticide which would kill half of a large number of test animals if eaten or absorbed through the skin. (Note: The lower the LD number value, the more poisonous the pesticide. LD number values are the commonly used measures of acute oral or acute dermal toxicity. LD stands for lethal dose.)

Lethal — deadly.

Monitoring system — regular system of keeping track of and checking up on whether or not pesticides are escaping into the environment.

Neoprene — a kind of synthetic rubber.

Nonselective — pesticide which is toxic to all or most plants or animals of a type; usually used to describe a particular type of pesticide. For example, a nonselective herbicide would kill or injure all plants in the application site but not all insects, animals, or other organisms.

Oral — though the mouth.

Original container — package (bag, can, or bottle) in which a pesticide is sold. (Note: The package must have a label telling what the pesticide is, how to use it correctly and safely, and how to safely dispose of the empty container.)

Pesticide — chemical or other substance that will destroy or control a pest or protect something from a pest.

Phytotoxicity — causing injury to plant life.

Pollute — to make unclean or unsafe.

Private applicator — a certified applicator who uses or supervises the use of any pesticide classified for restricted use for the purpose of producing any agricultural commodity on the property owned or rented by him or his employer or on the property of another person producing any agricultural commodity in exchange for personal services.

Reentry interval — period of time between a pesticide application and when persons may reenter an area without wearing protective clothing and equipment.

Residual (persistent) — Pesticide that remains in the environment for a fairly long time.

Respirator — face mask which filters out poisonous gases and particles. (Note: A respirator is used to protect the nose, mouth, and lungs from pesticide injury.)

Selective — pesticide which is more toxic to some types of plants or animals than to others; usually used to describe a particular type of pesticide. For example, a selective herbicide would kill crabgrass in a corn field but would not injure the corn.

Sensitive — easily injured.

Short-term (nonpersistent) — pesticide that breaks down almost immediately into nontoxic by-products.

Soil injection — method of incorporation of pesticides by putting them within the plow layer of soil by usual tillage practices.

Stomach poison — pesticide which kills when swallowed.

Surface spray — pesticide spray which is evenly applied to the outside of the object to be protected.

Systemic — pesticide that is taken up by one part of a plant or animal and moved to another section where it acts against a pest.

Target — pest to be treated with a pesticide.

Tolerance — Maximum amount of pesticide which can legally remain on or in any food or feed crop at harvest or animal at slaughter.

Vaporize — to form a gas and disappear into the air.

Definitions take from *Principles of Pesticide Use, Handling, and Application* Instructional Modules.

INFORMATION SHEET #8

Items Pesticide Applicators and Operators are Expected to Know for Certification

1. Understand labels and labeling information and the classification of pesticides, general or restricted use.
2. Know the causes of pesticide accidents and how to guard against injury.
3. Realize the need for protective clothing and equipment.
4. Recognize the symptoms of pesticide poisoning and be able to administer appropriate first aid treatment.
5. Know how to handle, store, and dispose of pesticides properly.
6. Be aware of the influence of pesticides on the environment.
7. Identify common pests to be controlled.
8. Be familiar with pesticide formulations and factors affecting their effectiveness.
9. Know the common types of equipment and techniques of application.
10. Know how to calibrate application equipment.
11. Understand laws and regulations.

INFORMATION SHEET #9

How and Why to be Certified as a Private Pesticide Applicator

One way to become certified is to complete a local training session conducted by the Cooperative Extension Service, University of Illinois. An official of the Illinois Department of Agriculture will be present at the training session to register those attending.

Each person seeking certification must fill out an application, complete the questions in a training evaluation form, and sign a statement saying that he or she understands the information presented at the training session and the legal responsibilities for the use of pesticides in accordance with label instructions.

A second way to become certified, as an alternative to participating in a training session, is to take a written examination for certification as Private Pesticide Applicator. The examination will be graded, and a passing grade must be achieved to obtain certification. The examination is "open book," and is available from the county extension advisor, or the state or regional offices of the Illinois Department of Agriculture. There is no fee for certification as a Private Pesticide Applicator. Certification is valid for five years.

Certification of application is required by federal regulations.

Federal Environmental Pesticide Control Act (The Federal Insecticide, Fungicide, and Rodenticide Act of 1947, amended in 1972 - FIFRA) regulated the use of pesticides to protect humans and the environment.

The 1947 Act was designed to regulate the marketing of pesticides, especially those "economic poisons" which were moved through interstate commerce.

The 1972 Act went much farther in regulating the use of pesticides, the certification of applicators, and the marketing of pesticides at both the interstate and intrastate levels.

INFORMATION SHEET #10

Advantages and Disadvantages of Application Equipment

Equipment	Advantages	Disadvantages
Aerosol (bomb and generator)	Penetration of cracks and crevices; ability to reach all pests within the area; area usable soon after treatment by ventilation	No deposit, therefore only pests in the area during application are reached; difficulty in getting long-term control; necessity of special pesticide formation; drift hazard
Duster (hand and power)	Light weight; low cost; no water requirement	Drift hazard; high cost of pesticide; difficulty in controlling amount of application; separate calibration for each pesticide
Back rubber (rubbing post, dust bag)	Long-time use; low cost; portable device	Use on livestock only; amount of application not controllable; chance of not being used by all animals
Granular applicator	Light weight; no water requirement; use in fertilizer spreader or seeder	High cost of pesticide; limited foliar use; separate calibration for each pesticide
Hand sprayer	Low cost; simple and easy use and cleaning	No practical use for large areas; lack of agitation; possibility of wettable powder clogging nozzles
Air-blast sprayer	Good coverage and penetration; use of low-pressure pump and mechanical agitation	Drift hazard; chance of overdose; difficulty in using in small areas; difficulty in confining discharge to a limited target
Low-pressure field sprayer	Low cost; light weight; versatility; rapid coverage of large areas	Pesticide penetration limited by low-volume output; limited agitation
High-pressure field sprayer	Well-built construction; long life; usually mechanical agitation; great versatility	High cost; large water, power, and fuel requirements; heavy tire loads; drift hazard
Ultra-low volume sprayer	No water requirement; equal control with less pesticide	No provision of thorough wetting; hazard in using high concentrations; chance of overdose; use with only a small number of pesticides

INFORMATION SHEET #11

Poisoning Symptoms and First Aid Treatments

Mild Poisoning Symptoms

- fatigue
- headache
- dizziness
- blurred vision
- excessive sweating and salivation
- nausea and vomiting
- stomach cramps and diarrhea

Moderate Poisoning Symptoms

- inability to walk
- weakness
- chest discomfort
- muscle twitches
- constriction of pupil of the eye
- increased severity of earlier symptoms

Severe Poisoning Symptoms

- unconsciousness
- severe constriction of pupil of eye
- muscle twitches
- secretions from mouth and nose
- breathing difficulty
- death if not treated

Illness may be delayed a few hours. But if signs or symptoms start more than 12 hours after you were exposed to the pesticide, you probably have some other illness. Check with your physician to be sure.

First Aid Procedures

Read the directions in the "Statement of Practical Treatment" on each label. These instructions can save your life and the lives of your employees.

If you get a pesticide on your skin:

> Remove the pesticide as quickly as possible. Remove all contaminated clothing. Prompt washing may prevent sickness even when the spill is very large. Don't forget your hair and fingernails. Water-wettable powders of suspensions and most emulsifiable concentrates and emulsions are easy to remove with plain water. Solutions of pesticides in petroleum oil or other solvents are harder to remove without soap or a detergent. Detergents work better. Washroom and emergency field washing facilities should have detergents rather than plain soap.

If you inhale a pesticide:

> Get to fresh air right away.

If you splash a pesticide into your mouth or swallow it:

> Rinse your mouth with plenty of water. Go or be taken to a physician immediately. Because it is sometimes dangerous to cause vomiting, follow label directions.

INFORMATION SHEET #12

Passing Certification Tests

Objectives:

1. To make students aware of the activities involved in passing certification tests.
2. To have as many students as possible pass the private applicator's certification test.

Materials:

1. Information sheets from packet on who must be certified, and how this may be accomplished.

Procedure:

1. Contact local county extension advisor and inquire when the extension office will be holding a certification training session.
2. Arrange a field trip to the county extension office for the day of the certification test.
3. Have students complete training session and take certification test.

Questions:

1. How often are these training sessions held?
2. How else can one be certified if he or she does not attend one of these training sessions?
3. Why are these held at the local extension offices?

Observations:

Describe what you thought about the training session and the certification test.

Application:

Students who have passed the certification test will be able to buy restricted-use pesticides and apply them around their homes or farms.

TRANSPARENCY MASTER #1

Weeds Are Harmful in Many Ways

1. Reduced Yields
2. Reduced Quality of Products from Plants and Animals
3. Menace to Livestock and People
4. Losses from Disease and Insects Harbored by Weeds
5. Increase of Production Costs
6. Reduction of Land Values

TRANSPARENCY MASTER #2

Mechanical Control of Weeds

1. Cultivation
2. Mowing
3. Crop Rotation

TRANSPARENCY MASTER #3

Biological Control of Weeds

1. Description
2. Advantages
3. Limitations
4. Overall Goal

TRANSPARENCY MASTER #4

Chemical Control of Weeds

1. Introduction
2. Types of Treatments
    a. Broadcast
    b. Row or Band Treatment
    c. Spot Treatment
    d. Directed Sprays
3. Time of Treatment
    a. Preplant
    b. Preemergence
    c. Postemergence
4. Herbicide Types
    a. Contact Herbicide
    b. Systemic Herbicide
5. Physiological Factors
    a. Translocation
    b. Inactivation and Activation
6. Metabolic Factors

TRANSPARENCY MASTER #5

How Insects Are Harmful to Plants and Their Control

1. Corn
   a. European Corn Borer
   b. Southern Cornstalk Borer and Southwestern Corn Borer
   c. Chinch Bug
   d. Corn Ear Worm
   e. Corn Rootworms
      1) Northern and Western Rootworms
      2) Southern Rootworm
   f. Corn Root Aphid
2. Wheat
   a. Hessian Fly
   b. Wheat Jointworm

   c. Wheat Strawworm
   d. Wheat Stem Sawfly
   e. Greenbug
   f. Chinch Bug
   g. Grasshoppers

3. Soybeans
   a. Bean Leaf Beetle
   b. Mexican Bean Beetle
   c. Velvetbean Caterpillar

4. Alfalfa
   a. Alfalfa Weevil
   b. Potato Leafhopper
   c. Lygus Bug
   d. Alfalfa Aphid
   e. Spotted Alfalfa Aphid

TRANSPARENCY MASTER #6

Key Pesticide Indicators

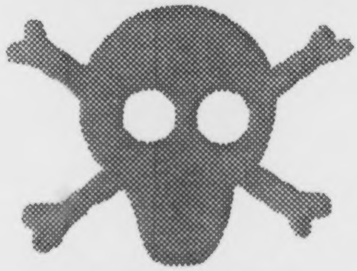
CAUTION

Slightly Toxic to Relatively Nontoxic

WARNING

Moderately Toxic

DANGER

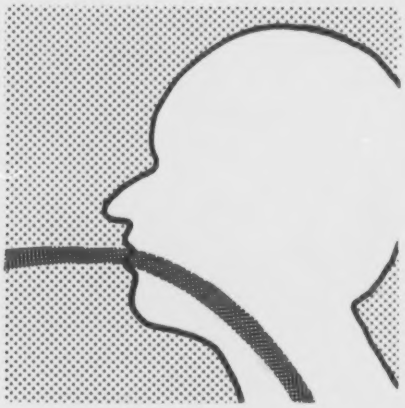


POISON

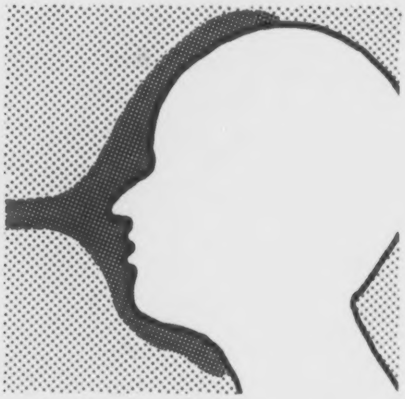
Highly Toxic

TRANSPARENCY MASTER #7

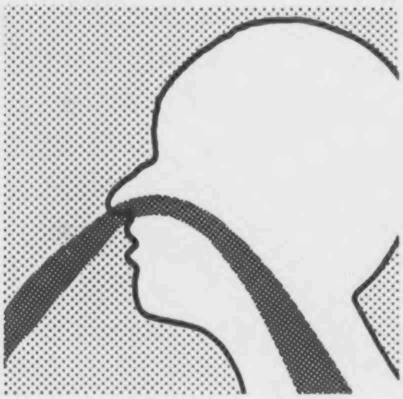
Methods of Pesticide Poisoning



Swallowing



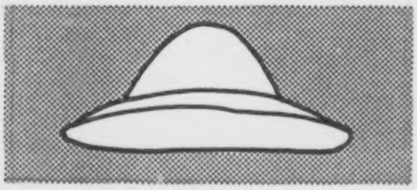
Exposure to Skin



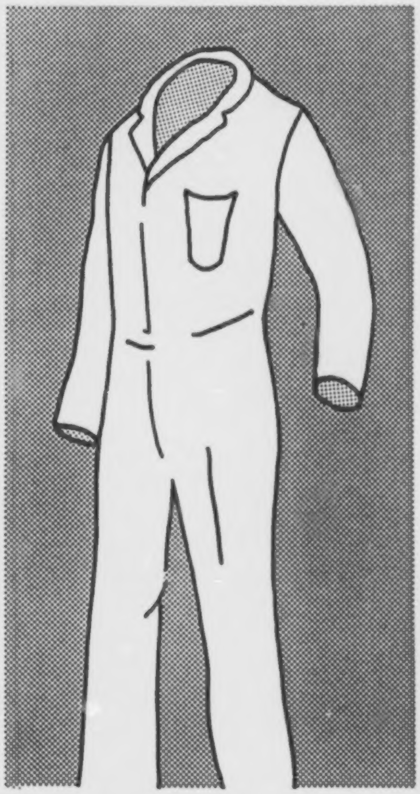
Breathing

TRANSPARENCY MASTER #8

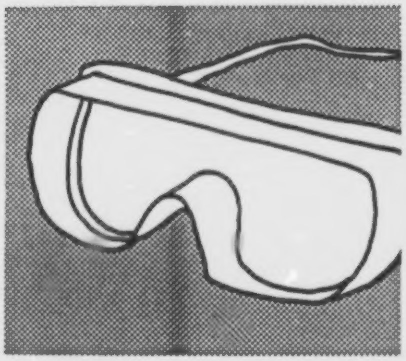
Recommended Protective Clothing and Equipment



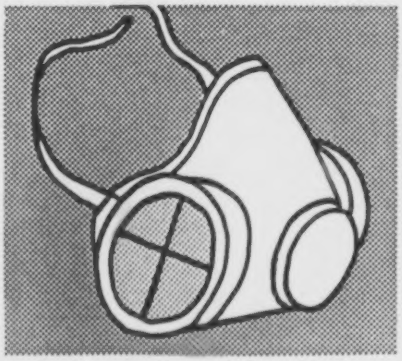
Waterproof Hat



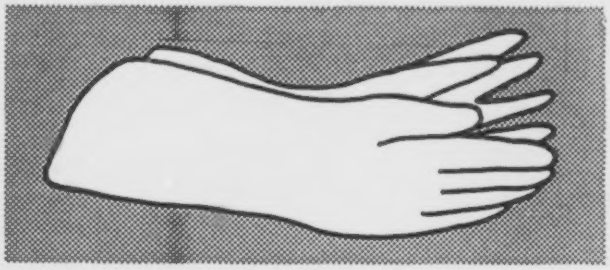
Closely Woven Fabric Coveralls



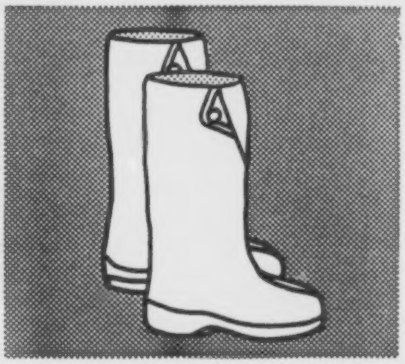
Goggles



Respirator



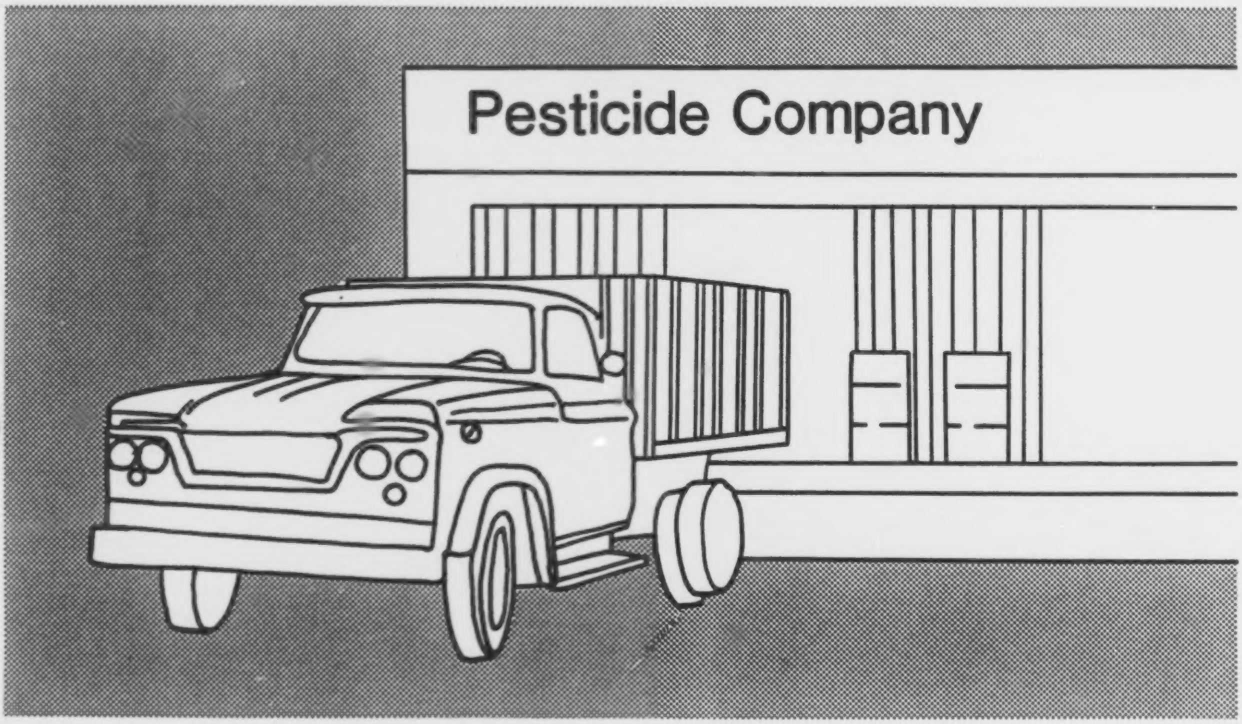
Long Rubber or Neoprene Gloves



Rubber or Neoprene Boots

TRANSPARENCY MASTER #9

Safest Method of Disposal of Highly Toxic Containers



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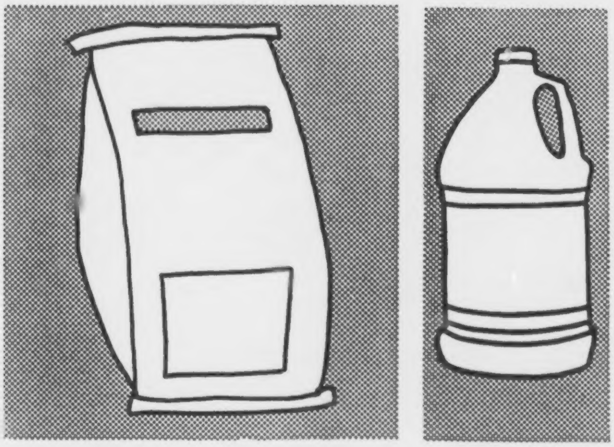
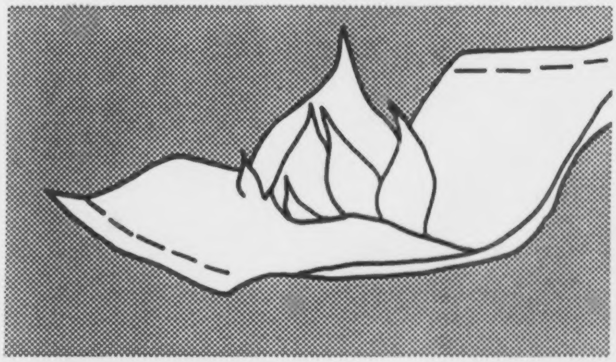
TRANSPARENCY MASTER #10

Other Methods of Disposal of Highly Toxic Containers

Burnable



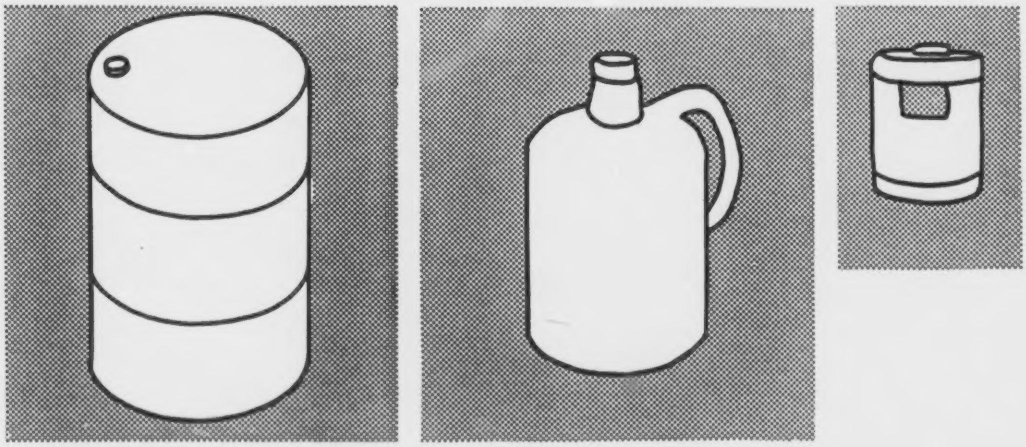


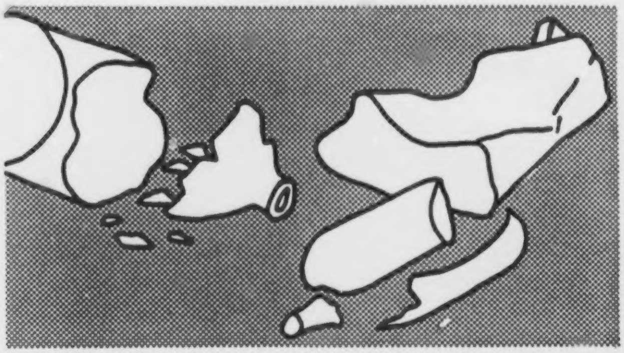
Burning

TRANSPARENCY MASTER #11

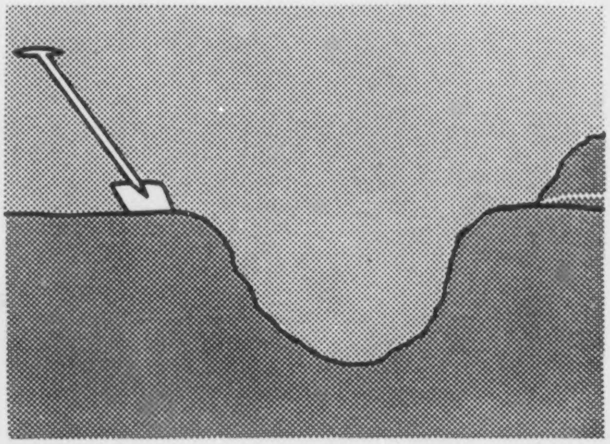
Other Methods of Disposal of Highly Toxic Containers

Nonburnable





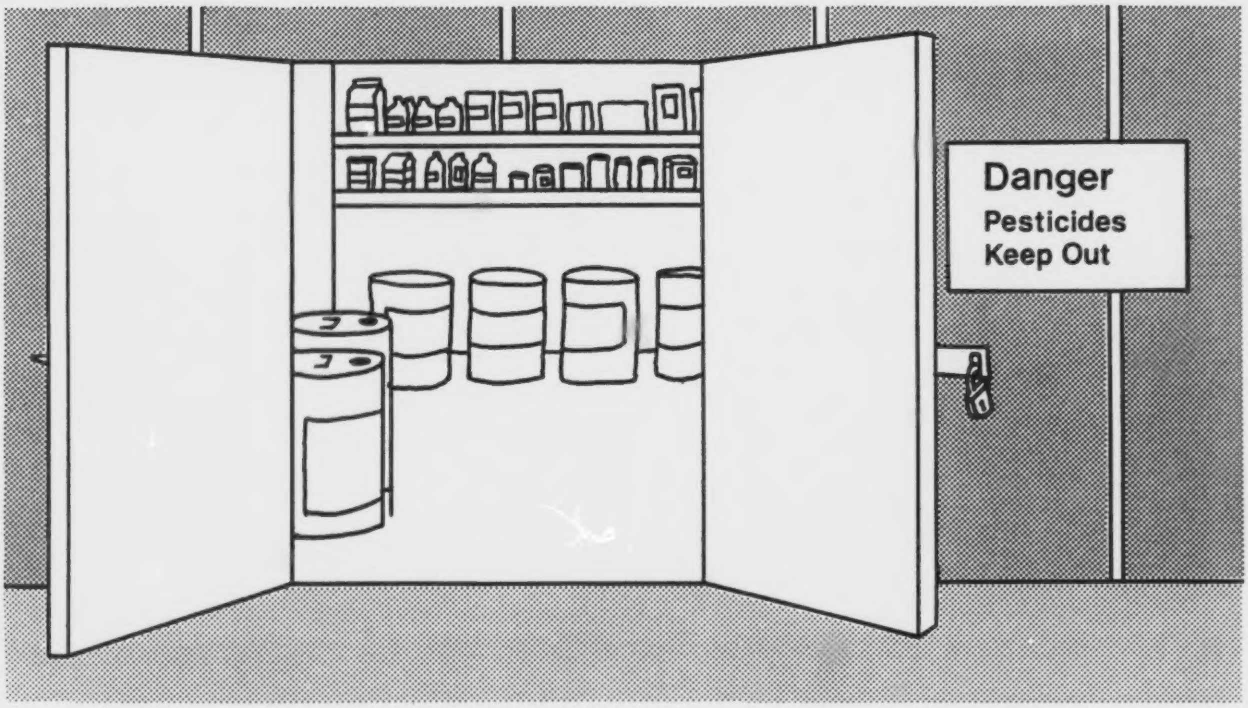
Break, Crush, or Cut Apart



Then Bury

TRANSPERANCY MASTER #12

Recommended Storage of Pesticides



Key Concepts

1. Store in separate building, room or enclosure.
2. Sacks, cartons, and fiber boxes should be stored on shelf.
3. Keep locked.
4. Use signs on outside of area.
5. Store only pesticides in area.
6. Make sure area is dry and the temperature can be controlled.
7. Store only in original containers with label in front.

STUDENT ACTIVITIES

STUDENT WORKSHEET #1 — Mechanical, Biological, and Chemical Control of Weeds

STUDENT WORKSHEET #2 — The Control of Weeds by Mechanical, Biological, and Chemical Means Word Search (with solution)

STUDENT WORKSHEET #3 — Reading Label Directions

STUDENT WORKSHEET #4 — Identification and Storage of Pesticides

For additional activities, teachers may refer to the "Suggested Teaching Activities and Procedures" section in the Instructor's Guide.

STUDENT WORKSHEET #1

Mechanical, Biological, and Chemical Control of Weeds

In the space provided below, describe in your own words the differences among mechanical, biological, and chemical control of weeds. If possible, give specific examples of cultural practices used to control weeds mechanically, biologically, and chemically.

STUDENT WORKSHEET #2

The Control of Weeds by Mechanical, Biological, and Chemical Means Word Search

E	Y	E	C	N	E	G	R	E	M	E	E	R	P	T	J	C	H	U	N
H	M	Y	Y	G	A	H	U	Q	C	H	J	B	G	G	P	G	C	G	G
N	O	S	T	Q	C	A	X	O	F	J	T	A	K	O	T	U	Q	H	D
O	W	P	W	I	T	D	N	I	J	H	C	O	S	V	R	F	D	Z	O
I	I	O	T	X	C	T	B	P	N	T	X	T	S	M	A	P	Z	A	L
T	N	T	W	N	A	I	Z	V	I	A	E	W	E	I	N	Y	B	V	A
A	G	T	D	C	E	T	X	V	E	M	C	T	E	T	S	M	A	N	C
T	U	R	T	I	X	M	A	O	E	C	A	T	N	U	L	V	Q	W	I
O	S	E	T	G	R	T	T	R	T	B	E	E	I	N	O	O	P	H	G
R	V	A	P	I	I	E	G	A	O	U	M	D	O	V	C	O	W	Q	O
P	A	T	C	O	P	E	C	L	E	T	U	I	I	T	A	X	L	B	L
O	T	M	N	D	N	U	I	T	A	R	T	I	C	C	T	T	C	Y	O
R	T	E	P	C	A	S	H	E	E	A	T	C	H	F	I	N	I	J	I
C	C	N	E	R	M	O	R	Z	V	D	V	W	I	V	O	B	R	O	B
J	P	T	A	B	E	T	R	I	S	E	S	V	O	M	N	C	R	F	N
F	M	G	X	V	D	P	T	B	R	Z	A	P	X	R	E	S	I	E	C
W	L	L	A	N	M	L	L	Q	W	U	A	O	R	S	V	T	R	T	H
A	H	C	A	E	U	V	Y	A	L	N	V	Y	K	A	T	X	S	G	Q
Z	T	B	V	C	K	M	C	N	N	L	D	G	A	C	Y	V	G	Y	Z
V	M	F	K	P	A	H	P	C	Q	T	N	X	O	N	F	S	X	J	S

The following words are hidden in the puzzle:

Activation
Band Treatment
Biological
Broadcast
Contact
Crop Rotation
Cultivation
Directed Sprays
Herbicide
Inactivation
Metabolism
Mowing
Post-emergence
Pre-emergence
Preplant
Row Treatment
Spot Treatment
Systemic
Toxicity
Translocation

STUDENT WORKSHEET #2 — Key

The Control of Weeds by Mechanical, Biological, and Chemical Means Word Search

•	•	E	C	N	E	G	R	E	M	E	E	R	P	•	•	•	•	•	•
•	M	Y	•	•	•	•	•	•	C	•	•	•	•	•	P	•	•	•	•
N	O	S	T	•	•	•	•	O	•	•	•	A	•	O	T	•	•	•	•
O	W	P	•	I	•	•	N	I	•	•	C	•	S	•	R	•	•	•	•
I	I	O	T	•	C	T	•	•	N	T	•	T	•	M	A	•	•	•	L
T	N	T	•	N	A	I	•	•	I	A	E	•	E	•	N	•	•	•	A
A	G	T	D	C	E	•	X	V	•	M	C	T	•	T	S	•	•	•	C
T	•	R	T	I	•	M	A	O	E	•	A	T	N	•	L	•	•	•	I
O	S	E	•	•	R	T	T	R	T	B	E	E	I	N	O	•	•	•	G
R	•	A	•	•	I	E	G	A	O	•	M	D	O	V	C	•	•	•	O
P	•	T	C	O	•	E	C	L	E	T	•	I	I	•	A	•	•	•	L
O	•	M	N	D	N	•	I	T	A	R	T	•	•	C	T	T	•	•	O
R	•	E	P	C	A	S	•	E	E	A	T	C	•	•	I	•	I	•	I
C	•	N	E	R	M	O	R	•	V	D	•	W	I	•	O	B	•	O	B
•	•	T	•	•	E	T	R	I	•	•	S	•	O	M	N	•	R	•	N
•	•	•	•	•	D	P	T	B	•	•	•	P	•	R	E	•	•	E	•
•	•	•	•	N	.	L	L	•	•	•	•	•	R	•	•	T	•	•	H
•	•	•	A	•	U	•	•	A	•	•	•	•	•	A	•	•	S	•	•
•	•	B	•	C	•	•	•	•	N	•	•	•	•	•	Y	•	•	Y	•
•	•	•	•	•	•	•	•	•	•	T	•	•	•	•	•	S	•	•	S

The following words are hidden in the puzzle:

Activation
Band Treatment
Biological
Broadcast
Contact
Crop Rotation
Cultivation
Directed Sprays
Herbicide
Inactivation

Metabolism
Mowing
Post-emergence
Pre-emergence
Preplant
Row Treatment
Spot Treatment
Systemic
Toxicity
Translocation

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STUDENT WORKSHEET #3

Reading Label Directions

(For use with example label in VAS Unit 4045A.)

1. What is the classification of the pesticide? ____________________

2. What is the company's brand name? ____________________

3. What type of pesticide it ? ____________________

4. What type of formulation is used in the pesticide? ____________________

5. What is the toxic chemical in the pesticide? ____________________
   What is the percent of active ingredient in the pesticide? ____________________

6. Which pests does this pesticide control? ____________________
   In what form should the moisture be applied? ____________________
   How much should be used? ____________________
   Where should the material be applied? ____________________
   When should it be applied? ____________________

7. How toxic is this pesticide? ____________________

8. What is stated in the Statement of Practical Treatment?

9. What is the manufacturer's name and address? ____________________
   Why is this important? ____________________

10. How should this pesticide be stored and disposed of?

11. What is the reentry period for this pesticide? ____________________

12. Does this pesticide have any precautionary statement? ____________________

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STUDENT WORKSHEET #3 — Key

Reading Label Directions

(For use with example label in VAS Unit 4045A.)

1. What is the classification of the pesticide? *Restricted-use pesticide*

2. What is the company's brand name? *De Pesto*

3. What type of pesticide it? *Insecticide*

4. What type of formulation is used in the pesticide? *Emulsifiable concentrate*

5. What is the toxic chemical in the pesticide? *Pestoff - trisalicylic acid*
   What is the percent of active ingredient in the pesticide? *45.0%*

6. Which pests does this pesticide control? *Alfalfa weevil, snout beetle*
   In what form should the moisture be applied? *Spray*
   How much should be used? *(Variety of answers)*
   Where should the material be applied? *Only in pure alfalfa fields*
   When should it be applied? *Only once per year when feeding is noticed*

7. How toxic is this pesticide? *Highly toxic*

8. What is stated in the Statement of Practical Treatment?

   If swallowed — induce vomiting by giving a tablespoonful of salt in a glass of warm water. Repeat until vomitus is clear. Call a physician immediately. If inhaled — remove to fresh air. Call a physician. If in eyes — flush eyes with plenty of water for at least 15 minutes. Call a physician. If on skin — remove contaminated clothing and immediately wash skin with detergent and water.

9. What is the manufacturer's name and address? *A-Z Chemicals, Chemton, Nevada*
   Why is this important? *In case user has a specific question about use of antidote for treatment*

10. How should this pesticide be stored and disposed of?

    Do not contaminate water, food, or feed by storage or disposal. Pesticide should be disposed of in a landfill approved for pesticides or buried in a safe place away from water supplies. Containers should be triple rinsed and offered for recycling or reconditioning, disposed of in an approved landfill, or buried in a safe place.

11. What is the reentry period for this pesticide? *48 hours*

12. Does this pesticide have any precautionary statement? *Yes*

STUDENT WORKSHEET #4

Identification and Storage of Pesticides

Purpose:

1. To make the students aware of the pesticides they use at home.
2. To develop the ability to recognize, classify, and store pesticides safely.

Materials:

1. sheet of paper
2. pencil or pen
3. pesticides on home farm or neighbor's farm

Procedure:

1. Have students look at the pesticides they have at home; or the instructor may set up a display of pesticides which the students can use for this activity.

2. The students should read the labels of the pesticides and give the following information for each pesticide.

   a. Name of pesticide
   b. What the pesticide controls
   c. Classification of pesticide
   d. How the pesticide should be stored

3. Submit list to instructor for evaluation.

Questions:

1. Were most of the pesticides general or restricted-use pesticides?

2. Would most require a person to have passed a certification test in order to use them?

3. Were the pesticides stored safely?

Observations:

If these pesticides were on your farm, how would you store them and label them?

Applications:

The students should be able to identify pesticides easier, and locate the important information on the labels.

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Maintaining Grain Quality

RELATED PROBLEM AREA(S):

1. Recognizing the Role of Agriculture in Society (Central Core Cluster)
2. Understanding the World Food and Fiber Chain (Central Core Cluster)
3. Identifying Basic Principles of Plant Science (Central Core Cluster)
4. Marketing Agricultural Products and Services
5. Advertising and Selling Agricultural Products and Services

PREREQUISITE PROBLEM AREA(S):

1. Recognizing the Role of Agriculture in Society (Central Core Cluster)

LEVEL: Preparatory

OCCUPATIONAL TASKS ADDRESSED:

Agricultural Business and Management Cluster

Duty M: Harvesting and Storing Crops

1. Monitor moisture content of stored crops
2. Determine marketing strategy
3. Transport crops to market
4. Test grain for moisture content

Duty Q: Loading, Securing, Transporting, and Unloading Agricultural Products

1. Unload grains such as corn, wheat, and soybeans
2. Unload grains

STATE GOALS FOR LEARNING:

In planning the instruction for this problem area, teachers can promote the development of several student learning objectives which are related to the State Goals for Learning in Sciences and Social Sciences. These objectives are listed on the Learning Assessment Plan forms included on the following page(s). Those learning objectives marked with an asterisk (*) are taken from the sample lists provided by the Illinois State Board of Education.

CORE

Illinois Agricultural Core Curriculum

Agricultural Education 124 Mumford Hall 1301 W. Gregory Drive University of Illinois Urbana, IL 61801

Director: Dale A. Law, Ed.D.
Principal Investigator: Jerry D. Pepple, Ed.D.
Research Assistant: Randy J. Bernhardt

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Agricultural Business and Management
Plant and Soil Science

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date ____________
☐ Original submission ☐ Revision
Page ____ of ____

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☒ Sciences ☐ Physical Development/Health

(Affix label or complete district information.)

COUNTY	DISTRICT	ESC

District Name
City

II. STATE GOAL FOR LEARNING
As a result of their schooling, students will have a working knowledge of the concepts and basic vocabulary of biological, physical, and environmental sciences and their application to life and work in contemporary technological society.

Contact Person: ____________
Title: ____________
Phone: ( )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
1. Select quality grain.					
2. Describe the factors which influence seed quality.					
3. Identify recommended procedures to follow when handling grain for seed.					
4. Understand the procedure and equipment involved in grain grading.					
5. Understand how grain quality changes during shipment.					
6. Understand how the grade factor can vary according to the method of sampling.					
7. Determine if current quality grain standards meet the needs of producers and processors.					

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ISBE 41-78 (1/88)

Submission Date ____________

☐ **Original submission** ☐ **Revision**

Page ____ of ____

I. LEARNING AREA *(check one)*

☐ Language Arts
☐ Mathematics
☐ Sciences
☐ Fine Arts
☒ Social Sciences
☐ Physical Development/Health

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)

COUNTY	DISTRICT	ESC

District Name

City

II. STATE GOAL FOR LEARNING

As a result of thier schooling, students will be able to understand and analyze comparative political and economic systems, with an emphasis on political and economic systems of the United States.

Contact Person: ____________
Title: ____________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
1. Develop an awareness of current issues in grain quality.					
*2. Understand how production decisions in our country are affected by conditions in other countries.					
3. Explain the importance of international grain markets.					
4. Understand the movement of corn, soybeans, and wheat through the market channels.					
*5. Analyze the economic interdependence among the Illinois, United States, and world communities.					

ISBE 41-78 (1/88)

Maintaining Grain Quality

Illinois Agricultural Core Curriculum Rev.

Agricultural Business and Management
Plant and Soil Science

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Maintaining Grain Quality

STUDENT LEARNING OBJECTIVES

Upon completion of their study of this problem area, students will be able to:

1. Select quality grain.
2. Describe the factors which influence seed quality.
3. Identify recommended procedures to follow when handling grain for seed.
4. Understand the procedure and equipment involved in grain grading.
5. Understand how grain quality changes during shipment.
6. Understand how the grade factor can vary according to the method of sampling.
7. Determine if current quality grain standards meet the needs of producers and processors.
8. Develop an awareness of current issues in grain quality.
9. Understand how production decisions in our country are affected by conditions in other countries.
10. Explain the importance of international grain markets.
11. Understand the movement of corn, soybeans, and wheat through the market channels.
12. Analyze the economic interdependence among the Illinois, United States, and world communities.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Maintaining Grain Quality

PROBLEMS AND QUESTIONS FOR STUDY

1. What does it mean when we talk about "grain quality"?
2. How is quality grain selected?
3. What factors do you think affect or influence the quality of seed?
4. How is grain seed handled? What are the recommended procedures for handling grain for seed?
5. Does grain quality change during shipment?
6. What is the relationship between the sampling method and the grade factor?
7. Do current grain standards meet the needs of producers?
8. Do current grain standards meet the needs of processors?
9. What are some of the current issues in the area of grain quality?
10. How are international grain markets important?
11. Through what market channels do corn, soybeans, and wheat move ?

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Maintaining Grain Quality

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES

1. As an interest approach to introduce the problem area, ask students the following question: "What is meant by grain quality?"

2. Distribute Student Worksheet #l. Using VAS Slidefilm *Seed Quality —A Major Factor in Crop Yields*, have students answer the questions on the worksheet (see reference list).

3. Distribute Student Worksheet #2. Using VAS Slidefilm *Factors Affecting Classes and Grades of Shelled Corn* and Slidefilm *Factors Affecting Classes and Grades of Soybeans*, have students complete the worksheet (see reference list).

4. Show the video entitled *Grain Quality: The American Commitment*, available from the University of Illinois Film Center (see reference list).

5. Discuss the procedure and equipment involved in grain grading. Refer to Information Sheet #1 and Transparency Masters #1 - #3.

6. Arrange a field trip to a grain elevator or grain terminal. Ask the manager to give the class a tour of the facilities. Also have one of the employees conduct and explain tests taken for grain samples.

7. Discuss the changes in quality of grain that can occur during shipment. Refer to Information Sheet #2 which can be copied for students.

8. Obtain a copy of bulletin AE-4439, *Grade Factor Variation When Sampling Grain in Trucks*, available from the Department of Agricultural Economics, University of Illinois, Urbana-Champaign (see reference list). Conduct a discussion on how sample results can vary.

9. Refer to Information Sheet #3 to begin a class discussion on the current method of grading soybeans and whether the standards should be changed.

10. Ask students, "What are the current issues in grain quality?" Refer to the materials entitled *Meeting the Competition . . . Understanding the Issues in Grain Quality*, available from the Department of Agricultural Economics, University of Illinois, Urbana-Champaign (see reference list). Use this information in conjunction with the video *The Export Quality Challenge*, available from the University of Illinois Film Center (see reference list).

11. Prepare students for competition on a Crops Judging team. Refer to Information Sheets #4 and #5 and Student Worksheet #3.

12. Begin a discussion of the importance of international grain markets. Show slide set *Let's Meet the Competition* (see reference list).

13. Transparency Masters #5 - #7 show the market channels that corn, soybeans, and wheat move through. Discuss these market channels with the class.

14. Use selected Modules from *Applied Communication* to develop workplace language.

15. Discuss the ethics of grain marketers not obeying regulations on quality standards.

INSTRUCTOR'S NOTES AND REFERENCES

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INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Maintaining Grain Quality

REFERENCES

INSTRUCTOR'S NOTES AND REFERENCES

1. *Storage of Cereal Grains and Their Products.* (1982). American Association of Cereal Chemists, Inc., 3340 Pilot Knob Road, St. Paul, MN 55121.

*2. *Seed Quality — A Major Factor in Crop Yields* (VAS Slidefilm #F796); *Factors Affecting Classes and Grades of Shelled Corn* (VAS Slidefilm #F734); *Factors Affecting Classes and Grades of Soybeans* (VAS Slidefilm #F746). Vocational Agriculture Service, College of Agriculture, University of Illinois, 1401 S. Maryland Drive, Urbana, IL 61801. (217) 333-3871.

*3. *Meeting the Competition. . .Understanding the Issues in Grain Quality; Corn Quality: Changes During Export* (Special Publication 58); *Illinois Research* (Volume 29, Numbers 2/3, Summer/Fall 1987); *Changes in Quality of Grain During Overseas Shipment; Grade Factor Variation When Sampling Grain in Trucks* (#AE-4439); *Production, Utilization, and Marketing Patterns for Illinois Grains and Soybeans* (#AER-196); *Let's Meet The Competition* (Slide Set). Hill, Lowell D. University of Illinois, Department of Agricultural Economics, 218 Mumford Hall, 1301 W. Gregory Drive, Urbana, IL 61801. (217) 333-1810.

*4. *Grain Quality: The American Commitment* (Film by Lowell D. Hill); *The Export Quality Challenge* (Film by Lowell D. Hill). University of Illinois Film Center, 1325 S. Oak Street, Champaign, IL 61820. (800) 252-1357 (inside Illinois); (800) 367-3456 (outside Illinois).

5. *Applied Communication.* Curriculum Publications Clearinghouse, Western Illinois University, Horrabin Hall 46, Macomb, IL 61455.

*Indicates highly recommended reference

INSTRUCTIONAL RESOURCES

These resources are intended for use by teachers in planning and teaching the materials for this problem area and may be adapted to fit the teaching method(s) used.

INFORMATION SHEET #1 — Procedure and Equipment Involved in Grain Grading

INFORMATION SHEET #2 — Changes in Quality of Grain During Overseas Shipment

INFORMATION SHEET #3 — Revising the Standards — Soybean Seed Quality

INFORMATION SHEET #4 — Things to Look for When Judging Crops

INFORMATION SHEET #5 — Judging Quality of Grain for Seed and for Market

TRANSPARENCY MASTER #1 — Procedure and Equipment Involved in Grain Grading

TRANSPARENCY MASTER #2 — Equipment Used for Grain Grading

TRANSPARENCY MASTER #3 — Equipment Used for Grain Grading

TRANSPARENCY MASTER #4 — Sieves — Types and Functions

TRANSPARENCY MASTER #5 — Simplified Flow Diagram of Illinois Wheat Marketings

TRANSPARENCY MASTER #6 — Simplified Flow Diagram of Illinois Soybean Marketings

TRANSPARENCY MASTER #7 — Simplified Flow Diagram of Illinois Corn Marketings

INFORMATION SHEET #1

Procedure and Equipment Involved in Grain Grading

Procedure

1. Take a representative sample of the grain.
2. Conduct the following tests on the grain sample:
   - a. Percent moisture
   - b. Test weight per bushel
   - c. Determination of amount of foreign material and broken kernels

Equipment

1. Boerner divider (laboratory model) — This device is used to reduce the size of a sample of grain while maintaining the representativeness of the original sample.
2. Moisture meter — The Motomco moisture meter, presently prescribed by the USDA for determining the moisture content of any grain for which standards have been established, measures the electrical capacity of the grain. This value is then converted to percent moisture through use of moisture conversion charts.
3. Test weight per bushel apparatus — Test weight per bushel is the weight of the volume of grain required to fill, level full, a Winchester bushel. Test weight per bushel tends to increase as moisture content decreases, so the test should be taken as quickly as possible after the grain has been delivered to the laboratory.
4. Scales — These are of two types:
   - a. Toledo scale — This device is used for weighing all portions of grain in excess of 50 grams.
   - b. Torsion balance — This type of scale is used for weighing all small portions of a sample.
5. Carter dockage tester — The tester is used to remove dockage material from wheat, rye, barley, sorghum, flaxseed, and triticale and to remove broken kernels and foreign material from corn and sorghum. It comes equipped with specially constructed sieves and riddles.
6. Barley pearler — The pearler removes the outer hull and bran layers from barley kernels, thereby permitting the inspector to determine kernel texture and whether heat damage is present.

INFORMATION SHEET #2

Changes in Quality of Grain During Overseas Shipment

With increased volumes of agricultural exports, concern has grown about the quality of grain delivered to foreign buyers. Basic information is needed on changes in quality during transportation from U.S. farms to other countries.

In a series of case studies we are systematically evaluating grain quality at each point in the market channel. The first study involved a shipment of 1974 crop corn from Toledo to Rotterdam. Results have been reported in papers published by the Departments of Agricultural Economics and Agricultural Engineering.

The second study concerned a shipment of 1975 crop corn from Peoria to Mexico. The shipment consisted of 4,026 metric tons (158,500 bushels) of shelled corn, which had been trucked from Illinois country elevators to a Peoria river terminal in November, 1975.

The corn was unloaded through the elevator legs into three barges, which were then sealed under supervision of the Agricultural Marketing Service (AMS), USDA. Three weeks later, the barges arrived at Reserve, Louisiana (New Orleans port area). After being inspected, they were unloaded via marine legs. The corn was moved by endless belts and dropped into concrete storage bins. Later it was loaded into hold No. 2 of the ocean vessel, Union Defender. One week after loading, the Union Defender arrived at Coatzacaolcos, Mexico, where the corn was manually unloaded with canvas slings into rail cars.

Sampling Points

Samples of corn were collected at nine points in the marketing channel under supervision of personnel from the field offices of the AMS, the Peoria Board of Trade, and the Destrehan Board of Trade. The nine sampling points were:

At Peoria: (1) One composite probe sample from each truckload before unloading. (2) Diverter samples of each 15,000-bushel sublot as barges were loaded. (3) Probe samples according to AMS pattern specification after barges were loaded.

At Reserve: (4) Probe samples from each barge before unloading. (5) Diverter samples at 10,000-bushel intervals from the corn outbound to hold No.2 of the Union Defender. Similar diverter samples were taken from 4,921 metric tons (193,740 bushels) of U.S. No.2 corn being loaded into hold No. 5, although the history of that corn was unknown. (6) Twenty-four probe samples from each of three layers in hold No. 2 during loading; also probe samples from hold No. 5.

In Mexico: (7) Probe samples of holds No. 2 and 5 when hatches were opened at Coatzacoalcos. Due to lack of time and personnel, only the top layers were sampled. (8) Prove samples of corn from hold No. 5 after it was loaded into rail cars at Coatzacoalcos. (9) Samples from rail cars after unloading at final destinations of Mexico City and Cuernavaca.

Changes in BCFM

The most important quality change in the corn during handling and transportation from Peoria to Mexico was an increase in the percentage of broken corn and foreign material (BCFM).

The corn in the trucks at Peoria contained only 1.24 percent BCFM (Table 1). By the time the corn was moved out of storage at Reserve, however, BCFM was above the maximum allowable for No. 2 corn. The corn was cleaned and about 2 percent of the original weight was removed as screenings. After screening, BCFM based on diverter samples from the outbound belt was 2.65 percent. During loading BCFM increased to 3.21 percent in the composite samples from hold No. 2 of the Union Defender.

Average BCFM in Coatzacoalcos was 3.28 percent - not significantly greater than at Reserve. If the corn had not been screened at Reserve, BCFM at Coatzalcoalcos would have been at least 5.23 percent.

In the corn of unknown origin, BCFM was 2.43 percent in diverter samples outbound to hold No. 5 of the Union Defender (Table 1). After reaching Mexico City, this corn averaged 4.07 percent BCFM.

Table 1. - Official BCFM Determinations by Agricultural Marketing Service

Location	Peoria-origin corn			Unknown-origin corn		
	Av. pct. BCFM	Standard deviation	No. of samples	Av. pct BCFM	Standard deviation	No. of samples
Peoria probe samples from trucks	1.24	0.657	198	...	...	..
Peoria diverter samples of corn outbound to barges	1.82	0.195	12	...	...	..
Peoria probe samples from barges	2.22	0.324	12	...	...	..
New Orleans probe samples from barges	2.37	0.493	3	...	...	..
New Orleans diverter samples of corn outbound to Union Defender	2.65	0.722	16	2.43	0.529	18
New Orleans probe samples from Union Defender	3.21	0.336	11	4.08	0.443	12
Coatzacoalcos probe samples from Union Defender	3.28	0.403	4	4.00	0.566	4
Coatzacoalcos probe samples from railroad cars	...	...	..	4.75	0.855	20
Mexico City and Cuernavaca final destination samples	...	...	..	4.07	0.489	7

Other quality changes

Each sample was evaluated in the Agricultural Engineering Laboratory at the University of Illinois for six quality factors: (1) moisture content, (2) test weight, (3) particle size distribution, (4) percent whole kernels, (5) stress cracks, and (6) susceptibility to breakage as measured by Stein breakage tests.

Moisture was the only factor that remained relatively constant (about 14.5 percent) from Peoria to Mexico; the other factors changed significantly (Table 2). The increased test weight was apparently due to increased fine materials in the corn.

Although the corn had been artificially dried before being shipped to Peoria, no screenings had been removed. However, the corn was originally of high quality as indicated by an average of 1.24 BCFM, test weight of 57.4 pounds per bushel, and 88.3 percent whole kernels in the truck samples. By the time the corn reached Coatzacoalcos, quality had declined, as evidenced by 5.23 percent BCFM (including screenings removed at the export elevator), test weight of 58.4 pounds per bushel, and 82.2 percent whole kernels.

Stein breakage tests and stress crack analyses revealed an often unnoticed grain characteristic - brittleness or susceptibility to breakage. Peoria-origin corn had an initial Stein breakage reading 3.07 percent, and 13.6 percent of the kernels had multiple stress cracks. After the corn had been unloaded from the barges, dropped into concrete storage bins in Reserve, and screened, the brittleness reading on the Stein breakage tests increased more than 100 percent (to 32.1 percent). Thus, the handling and dropping of corn did more than just increase BCFM; it also generated stress cracks in many kernels, weakening their structure and leaving them more susceptible to breakage during subsequent handling.

Comparison

The 1975 crop corn in the Peoria-Mexico shipment was of better quality and less brittle than the Toledo-Rotterdam shipment of 1974 crop corn. In corn samples taken from the export elevator at Toledo, 41.3 percent of the kernels showed multiple stress cracks, as compared to 32.1 percent of the kernels at Reserve.

The Stein breakage test also showed a greater susceptibility to breakage in the 1974 crop - 18.5 percent at Toledo in contrast to 6.3 percent at Reserve. Subsequently BCFM increased by 1.35 percentage points between the elevator and the hold of the vessel in Toledo compared to an increase of 0.56 percentage point during loading at Reserve.

Unloading procedures also significantly affected breakage. The pneumatic suckers and associated procedures in Rotterdam increased average BCFM by about 3.1 percentage points and decreased whole kernels by 2.6 percentage points. The hand unloading procedures in Mexico increased BCFM by 0.75 percentage point (primarily from the drop into the rail car) and did not affect the percentage of whole kernels.

The most important principle illustrated by this comparison is that breakage of corn can be reduced at almost every point in the market channel, since brittleness and breakage result from current practices of harvesting, drying, storing, loading, and unloading. However, reducing this quality loss generally incurs a cost of time, handling speed, or equipment. The grading and marketing system should be designed so that buyers can communicate their preference to various points in the market channel, indicating how much they are willing to pay for increased quality.

Table 2. - Evaluations of Peoria-origin Corn Transported Through the Market Channel to Coatzacoalcos, Mexico

Location	Moisture content, pct.	Breakage test, pct.	Whole kernels, pct.	Particles <4.76 mm., pct.	Test weight, lb./bu.	Multiple stress cracks, pct.
Peoria probe samples from trucks	14.86	3.07	88.33	3.44	57.37	13.6
Peoria diverter samples of corn outbound to barges	14.63	3.59	88.73	3.19	57.95	18.3
Peoria probe samples from barges	14.38	3.41	88.32	3.81	57.75	16.2
New Orleans probe samples from barges	14.44	3.16	88.52	3.96	57.97	32.1
Screening occurred at this point						
New Orleans diverter samples of corn outbound to Union Defender	14.46	6.34	86.86	4.26	57.59	. . .
New Orleans probe samples from Union Defender	14.51	6.76	84.21	4.95	58.26	. . .
Coatzacoalcos probe samples from Union Defender	14.10	9.59	82.15	5.21	58.35	. . .

Written by Lowell D. Hill, a professor of agricultural marketing, and Marvin R. Paulsen, research associate in agricultural engineering. Reprinted with the permission of Dr. Lowell Hill.

INFORMATION SHEET #3

Revising the Standards — Soybean Seed Quality

Although the official standards settled on some characteristics that have traditionally been considered indicators of quality — test weight, splits, damage, foreign material, color, and moisture content — researchers have long suggested using characteristics that provide information about the yield and quality of meal and oil. In addition to oil and protein quantity, estimates of value require information about the content of free fatty acids, hydratable phosphatides, and other chemical properties.

If information on end-use value were incorporated in the price of soybeans, it would provide economic incentives for changes in cultivars and cultural practices to deliver the product Japanese and European customers are eager to buy. A survey of European processors in 1986 revealed that 68% always test soybeans for damage levels at their plant; 84% test for oil content, 79% for protein content, and 58% for free fatty acid. U.S. grades provide information on only one of these factors — damage — and even that factor is based on a subjective determination that differs significantly from the definition of damage used by foreign processors. Research by Lowell D. Hill and his associates in the Department of Agricultural Economics at the University of Illinois indicated that the grades established in 1924 no longer meet the needs of current sophisticated producers and processors.

Studying the history and development of U.S. grain standards helps one understand the issues involved in the debate. Solutions to the problems with grain quality often are found in the actions of the past and economic incentives of the future. The viewpoints of others in the debate must be analyzed. In conjunction with the Farm Research Institute, farmers in Illinois, Indiana, and Iowa were surveyed to identify practices that influence quality and their preferences for alternative solutions. Currently, producers receive payments based on the lowest quality of beans in a load. Many producers indicate a willingness to accept discounts for low-quality beans if beans of above average quality were rewarded.

In Search of Soybean Quality. James B. Sinclair and Lowell D. Hill, Illinois Research, Volume 29, Numbers 2/3, Agricultural Experiment Station, College of Agriculture, University of Illinois at Urbana-Champaign.

INFORMATION SHEET #4

Things to Look For When Judging Crops

Corn

1. Kernels not uniform
2. Kernels showing wrinkling only on germ face, but not blistered
3. Kernels slightly lacking in luster
4. Kernels lacking in depth
5. Kernels lacking in thickness
6. Excessive crown starch
7. Light weight per bushel
8. Excessive number of tip caps broken off
9. Excessive chaff attached to tip
10. Shrunken kernel tips
11. Kernels exhibiting tip starch
12. Cracked or broken kernels
13. Kernels exhibiting back starch
14. Diseased kernels
15. Blistered or frozen kernels

Wheat

1. Seeds not uniform
2. Inert material
3. Broken or cracked seeds
4. Light weight per bushel
5. Mixture of spring and winter wheat
6. Mixture of other crops easy to separate
7. Common weeds
8. Shriveled berries (seeds)
9. Yellow berries
10. Mixture of classes other than spring and winter
11. Mixture of other crops hard to separate
12. Insect damage
13. Sprouted seeds
14. Diseased seeds
15. Heat-damaged seeds
16. Semiharmful weed seeds

Hay

1. Bleached color
2. Absence of leafness
3. Coarseness
4. Overripe condition
5. Mixture of legume hays (do not consider if judging mixed hay)
6. Mixture of other hays
7. Presence of inert material — stalky, stubble, etc.
8. Presence of common weeds
9. Presence of semiharmful weeds
10. Presence of noxious weeds
11. High moisture content
12. Moldy condition
13. Burned or heated hay
14. Charred hay

Soybeans

1. Beans not uniform
2. Inert material
3. Mottling
4. Scarification (open places in seed coat)
5. Poor color and luster
6. Low test weight per bushel
7. Undersized beans
8. Broken and cracked seeds
9. Mixture of other crops easy to separate
10. Common weed seeds
11. Unnatural green color
12. Swollen or shriveled beans
13. Other varieties of soybeans
14. Mixture of other crops hard to separate
15. Ground damage
16. Insect damage
17. Diseased and sprouted beans
18. Semiharmful weed seeds
19. Noxious weed seeds

Oats

1. Seeds not uniform
2. Clipping
3. Inert material
4. Hulling
5. Crops easy to separate (wheat or rye)
6. Common weeds
7. Light weight (below 32 lbs per bushel)
8. Weathered seeds
9. Musty seeds
10. Sprouted seeds
11. Other varieties of oats
12. Crops hard to separate (barley)
13. Diseased seeds
14. Semiharmful weeds
15. Noxious weed seed

Silage

1. Color
2. Grain content (stage of growth)
3. Moisture
4. Odor

INFORMATION SHEET #5

Judging Quality of Grain for Seed and for Market

To be certain that a variety is true to name, it is best to use seed which is certified.

Seed which is certified will bear a label which is similar to the one shown. All of the information would be included on the tag so you would know exactly what you were planting.

Variety — type of subdivision of soybean that you have.

Lot Number — limited to 5000 bushels of seed; seed of the same species and variety, grown in different fields but mixed to form a "lot."

Pure Seed — percentage of seed that will produce plants true to variety and type.

Inert Matter — percentage by weight of chaff, broken seeds, stems, and soil particles.

Weed Seeds — percentage by weight of seeds that are considered weeds.

Other Crop Seed — percentage by weight of seeds not of the specified variety.

Germination — percentage of seeds that will produce normal plants under normal conditions.

Hard Seeds — percentage of seeds which remain hard and sound at the end of a germination period.

Certified Seed Tag
Kind Variety Lot No
Origin
Purity % Weed Seed % Inert Matter %
Other Crop Seed % Germ. Date
Germination % Hard Seed %
Name and No. Noxious Weeds per oz.
Vendor
Address

In order to ensure a good crop, you must do a good job of selecting seed. Samples of soybean seed were checked and the analysis showed that farmers who purchased certified seed obtained a high-quality seed on the average than farmers purchasing uncertified seed.

This evidence indicates that the Illinois farmer could improve the potential of his soybean production by using higher quality seed.

Certified and Uncertified Soybean Seed Analysis (In percent)

Seed Type[1]	Germination	Pure seed	Weed seed	Inert matter	Other crops
Uncertified	80.2	95.5	.02	2.6	2.0
Certified	84.2	98.7	.001	1.2	.2

[1] Analysis on 363 samples of uncertified and 56 samples of certified.

TRANSPARENCY MASTER #1

Procedure and Equipment Involved in Grain Grading

Procedure

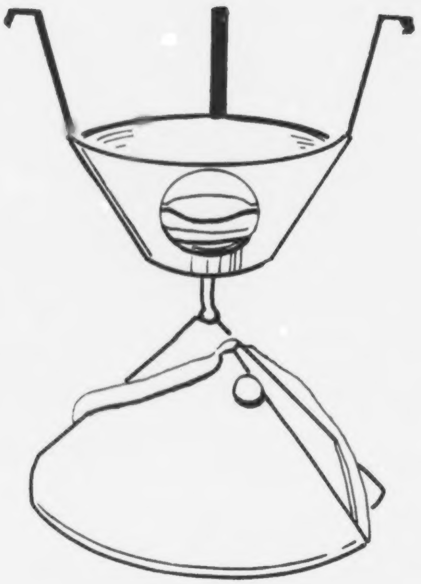
1. Take a Representative Sample of Grain
2. Conduct the Following Tests on the Grain Sample:
    a. Percent Moisture
    b. Test Weight/Bushel
    c. Determination of Amount of Foreign Material and Broken Kernels

Equipment

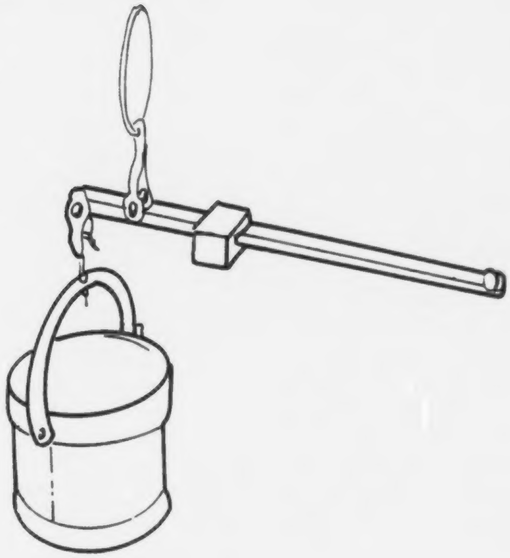
1. Boerner Divider
2. Moisture Meter
3. Test Weight Per Bushel Apparatus
4. Scales
5. Carter Dockage Tester
6. Barley Pearler

TRANSPARENCY MASTER #2

Equipment Used for Grain Grading



Spin Level Grain Spreader

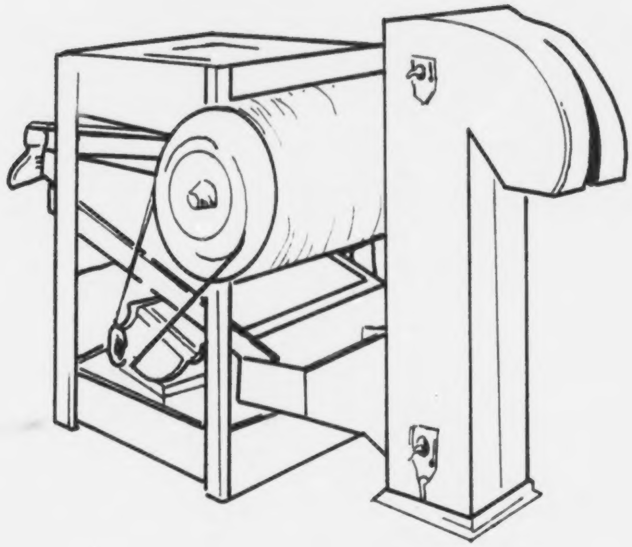


Weight per Bushel Tester

1191

TRANSPARENCY MASTER #3

Equipment Used for Grain Grading



Seed Cleaner and Grader

1192

TRANSPARENCY MASTER #4

Sieves — Types and Functions

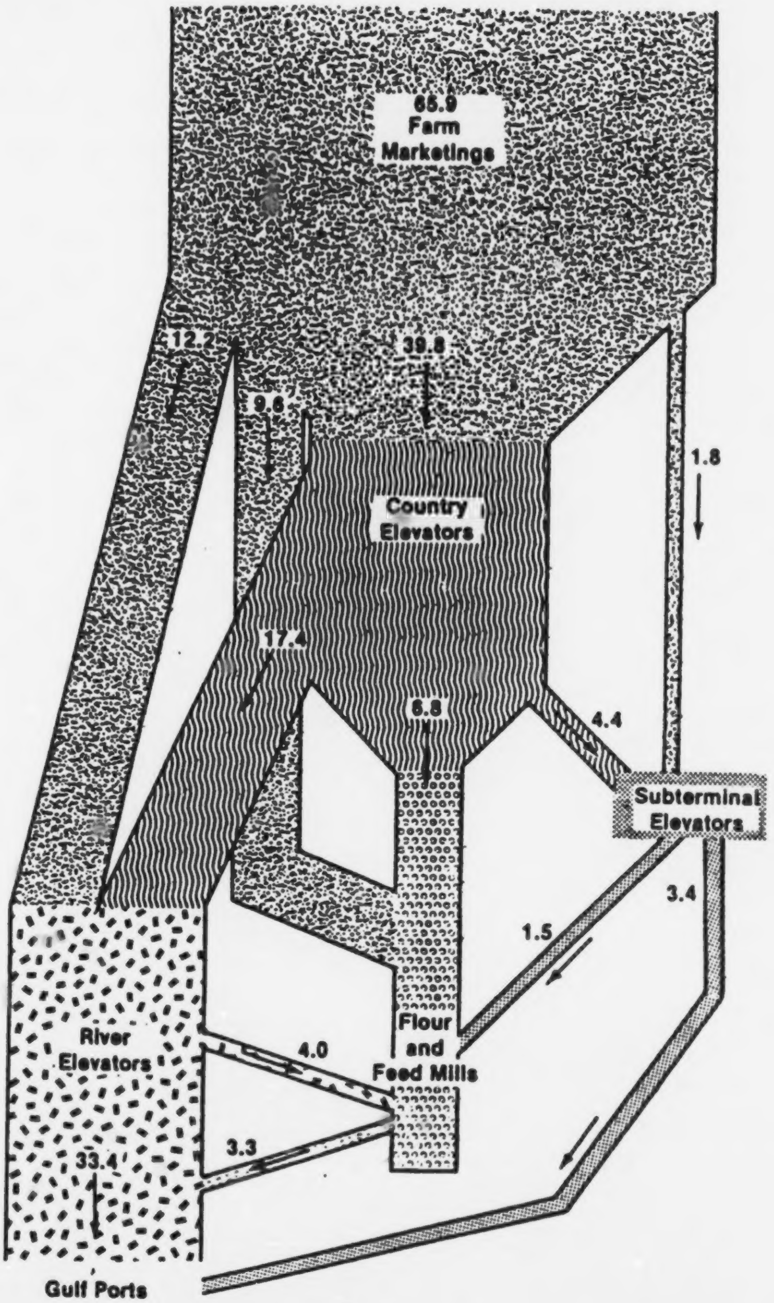
Sieve Type	Perforations	Functions
Corn	Round holes 12/64 in. (4.762 mm) in diameter	Removes (1) broken corn and foreign material from corn, and (2) coarse foreign matter from wheat and rye in the dockage determination of these grains when a Carter dockage machine is not available
Soybean foreign material	Round holes 8/64 in. (3.175 mm) in diameter	Removes fine foreign material for grading soybeans
Soybean split	Slots 10/64 x 3/4 in. (3.967 x 19.05 mm)	Facilitates the determination of splits in soybeans
Fine-seed	Round holes 1/12 in. (2.115 mm) in diameter	Removes fine seeds such as mustard in dockage determinations in wheat and rye
Sorghum dockage	Round holes 2 1/2/64 in. (0.993 mm)	Removes dockage in sorghum
Small buckwheat	Equilateral triangular; inscribed circles are 5/64 in.(1.983 mm) in diameter	Is used in determining dockage in barley; removes (1) wild buckwheat, foxtail, and seed of similar size in dockage determinations in wheat and rye, and (2) fine seeds in connection with the test for thin oats
Small chess	Slots 0.064 x 3/8 in. (1.625 x 9.525 mm)	Removes large-seeded flaxseed from wheat; determines (1) the factor "thin oats," and (2) the factor "shrunken and/or broken kernels" in wheat and "thin" in rye
Large chess	Slots 4 1/2/64 x 1/2 in. (1.785 x 12.700 mm)	Removes chess seeds, quackgrass, and similarly shaped seeds from wheat
Barley sizing	Slots 5/64 x 3/4 in. (1.983 x 19.05 mm)	Separates thin barley in grading six-rowed barley
	Slots 5 1/2/64 x 3/4 in. (2.181 x 19.05 mm)	Separates thin barley in grading two-rowed barley
Flaxseed dockage	Round holes 4 1/2/64 in. (1.785 mm) in diameter	Facilitates the removal of small seeds from flaxseed in determining dockage in flaxseed
Flaxseed	Slots 3/64 x 3/8 in. (1.191 x 9.525 mm)	Separates cereal grains and other coarse material from flaxseed; can also be used for removing flaxseed from wheat in wheat dockage determinations

Taken from *Storage of Cereal Grains and Their Products* . (1982). with permission from the American Association of Cereal Chemists, Inc. 3340 Pilot Knob Road, St. Paul, MN 55121.

TRANSPARENCY MASTER #5

Simplified Flow Diagram of Illinois Wheat Marketings

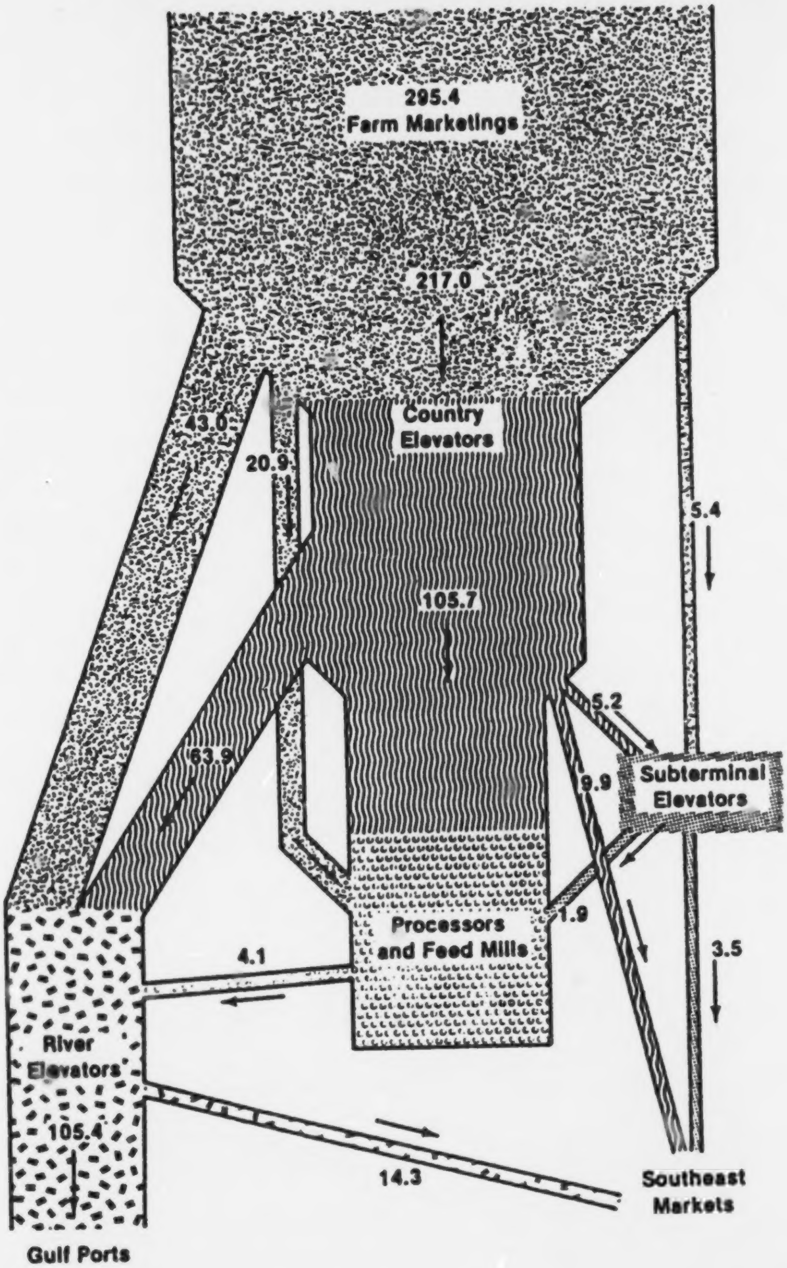
(Numbers in millions of bushels)


65.9
Farm
Marketings
12.2
39.8
9.6
1.8
Country
Elevators
17.4
6.8
4.4
Subterminal
Elevators
3.4
1.5
Flour
and
Feed Mills
4.0
3.3
River
Elevators
33.4
Gulf Ports

TRANSPARENCY MASTER #6

Simplified Flow Diagram of Illinois Soybean Marketings

(Numbers in millions of bushels)

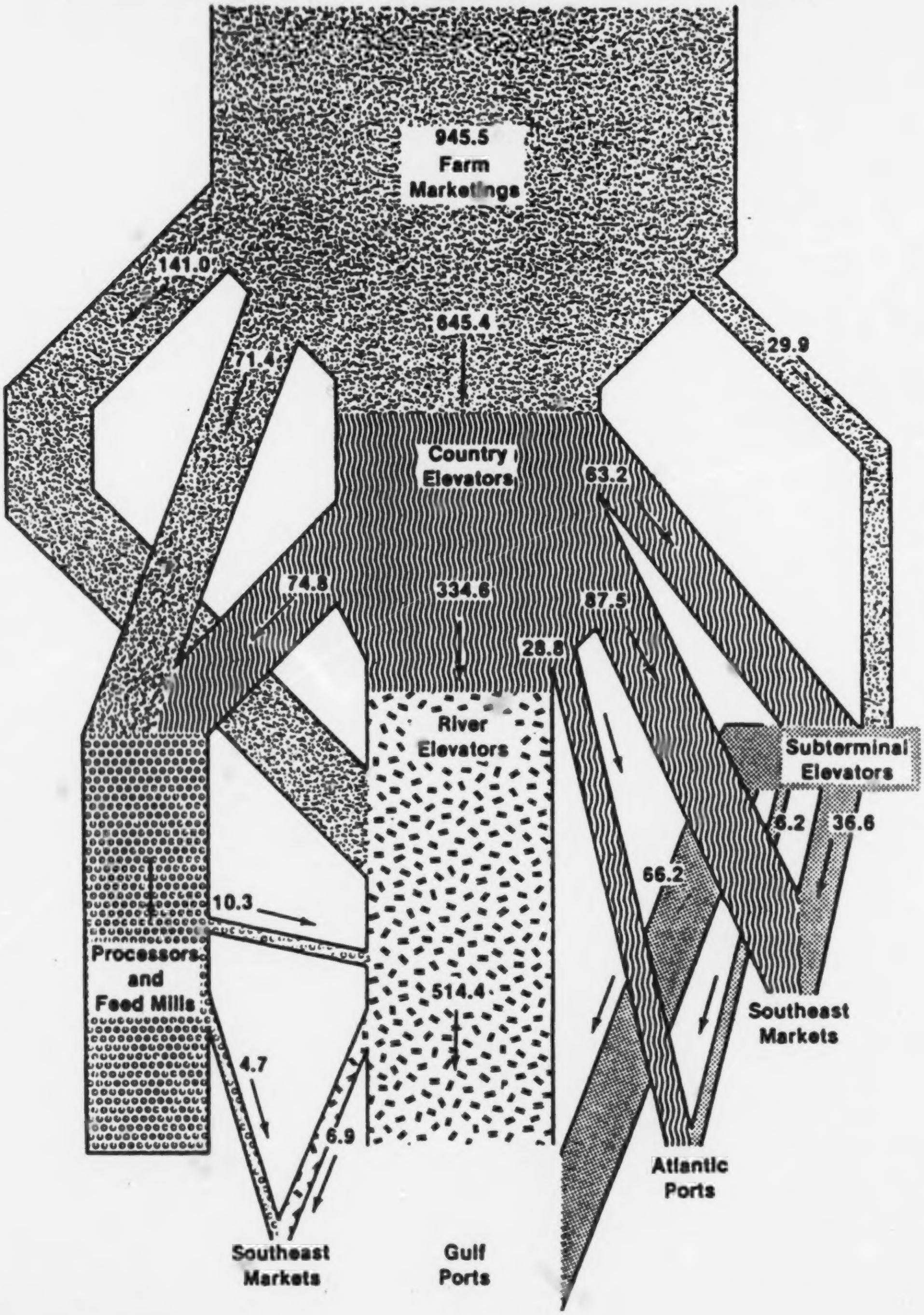

295.4
Farm Marketings
217.0
Country Elevators
43.0
20.9
5.4
105.7
5.2
63.9
9.9
Subterminal Elevators
Processors and Feed Mills
1.9
4.1
3.5
River Elevators
105.4
14.3
Southeast Markets
Gulf Ports

1195

TRANSPARENCY MASTER #7

Simplified Flow Diagram of Illinois Corn Marketings

(Numbers in millions of bushels)


945.5
Farm
Marketings
141.0
71.4
645.4
29.9
Country
Elevators
63.2
74.8
334.6
87.5
28.8
River
Elevators
Subterminal
Elevators
6.2
36.6
66.2
10.3
Processors
and
Feed Mills
514.4
4.7
6.9
Southeast
Markets
Atlantic
Ports
Southeast
Markets
Gulf
Ports

STUDENT ACTIVITIES

STUDENT WORKSHEET #1 — Factors Affecting Seed Quality

STUDENT WORKSHEET #2 — Factors Affecting Classes and Grades of Corn and Soybeans

STUDENT WORKSHEET #3 — Placing Rings of Crops

For additional activities, teachers may refer to the "Suggested Teaching Activities and Procedures" section in the Instructor's Guide.

STUDENT WORKSHEET #1

Factors Affecting Seed Quality

1. What resources need to be considered for obtaining top yields?

   a.

   b.

   c.

   d.

   e.

   f.

2. Describe how the use of poor quality seed can reduce crop yields.

3. What is meant by high-quality seed?

   a.

   b.

   c.

   d.

4. Where can you secure crop seed?

   Which is the best source? Why?

5. What information is contained on a seed tag? Explain each part.

6. Using certified seed will give you what assurances?

1198

STUDENT WORKSHEET #1 — Key

Factors Affecting Seed Quality

1. What resources need to be considered for obtaining top yields?

   a. *Land*

   b. *Fertilizer*

   c. *Labor*

   d. *Machinery*

   e. *Seed*

   f. *Pest control*

2. Describe how the use of poor quality seed can reduce crop yields.

   Low germination, weed problems, and less money at harvest

3. What is meant by high-quality seed?

   a. *Seed of high germination rate*

   b. *Seed that produces vigorous plants*

   c. *Seed containing minimum inert material*

   d. *Seed that produces high-yielding plants that are disease- and insect-resistant*

4. Where can you secure crop seed?

   Home grown, neighbor, elevator, seed dealer

   Which is the best source? Why?

   (Answers will vary)

5. What information is contained on a seed tag? Explain each part.

   (See Information Sheet #5)

6. Using certified seed will give you what assurances?

   Varietal purity, laboratory inspection, vigorous germination, absence of weeds, absence of other crop seed, cleanliness, cheaper cost of live seed per pound

STUDENT WORKSHEET #2

Factors Affecting Classes and Grade of Corn and Soybeans

1. Why is it important for a grower to have a knowledge of the classes and grades of crops?
   a.
   b.
   c.

2. Name the 3 classes of shelled corn.
   a.
   b.
   c.

3. What determines the grades of corn?
   a.
   b.
   c.
   d.

4. List the six types of damaged kernels.
   a.
   b.
   c.
   d.
   e.
   f.

5. Identify the classes of soybeans.
   a.
   b.
   c.
   d.
   e.

6. List the seven items affecting grades of soybeans.
   a.
   b.
   c.
   d.
   e.
   f.
   g.

7. What factors are considered for damage in soybean seed?
   a.
   b.
   c.
   d.
   e.
   f.
   g.
   h.
   i.

STUDENT WORKSHEET #2 — Key

Factors Affecting Classes and Grade of Corn and Soybeans

1. Why is it important for a grower to have a knowledge of the classes and grades of crops?
   a. *So grower will be paid for quality grain*
   b. *So buyer may purchase quality grain he or she requires*
   c. *To assist producer in better marketing of grain*

2. Name the 3 classes of shelled corn.
   a. *Yellow*
   b. *White*
   c. *Mixed*

3. What determines the grades of corn?
   a. *Minimum test weight per bushel*
   b. *Moisture content*
   c. *Cracked corn and foreign matter*
   d. *Damaged kernels*

4. List the six types of damaged kernels.
   a. *Heat*
   b. *Sprouted*
   c. *Ground and weather*
   d. *Frosted*
   e. *Insect*
   f. *Mixed*

5. Identify the classes of soybeans.
   a. *Yellow*
   b. *Green*
   c. *Brown*
   d. *Black*
   e. *Mixed*

6. List the seven items affecting grades of soybeans.
   a. *Test weight*
   b. *Moisture*
   c. *Splits*
   d. *Total damage*
   e. *Heat damage*
   f. *Percent foreign matter*
   g. *Mixture of other soybean varieties*

7. What factors are considered for damage in soybean seed?
   a. *Heat*
   b. *Sprouted*
   c. *Frosted and immature*
   d. *Weather*
   e. *Ground*
   f. *Moldy*
   g. *Materially damaged*
   h. *Diseased*
   i. *Insect*

1201

STUDENT WORKSHEET #3

Placing Rings of Crops

Objectives:

1. To understand how various factors affect quality of grain samples.
2. To become familiar with various factors affecting quality of grain samples.
3. To develop the ability to place samples of grain within a ring.

Materials:

1. grain samples of corn, oats, soybeans, wheat (available from Vocational Agriculture Service, University of Illinois)
2. flat pans or trays for each sample
3. judging cards

Procedure:

1. Begin by developing students' knowledge of factors to consider when looking at each sample. Discuss the importance of each factor.
2. Distribute the job sheet and give students the following information:
   a. Name of crop being judged
   b. Objectionable factors for each sample

   Have students give proper placing in each ring.
3. Use Information Sheet #4, "Things to Look for When Judging Crops," until students become familiar with the factors and their rank of importance. Use the problem areas Controlling Plant Pests and Classifying Plants for information on noxious and other weeds found in Illinois.
4. When students master the ranking of factors, set up rings of seed samples for students to place. Use job sheet and have students evaluate each grain sample in a ring. Write down the objectionable factors found in each sample and give proper placing for the grain ring.

________ Grain Being Judged

Sample No. 1

Objectionable factors

a.

b.

c.

d.

Sample No. 2

Objectionable factors

a.

b.

c.

d.

Sample No. 3

Objectionable factors

a.

b.

c.

d.

Sample No. 4

Objectionable factors

a.

b.

c.

d.

Final Placing

________ ________ ________ ________

Questions:

1. What is the difference between Primary Noxious and Secondary Noxious Weeds?
2. Why are mixed varieties objectionable when judging a sample of grain?
3. When evaluating samples for purity, what are some things to look for?
4. When evaluating samples for soundness, what are some things to look for?

Observation:

1. Become familiar with how factors are ranked from least to most objectionable in grain, hay, and silage samples.
2. Become familiar with primary and secondary (semiharmful) weeds and their seeds.
3. Correctly place a sample of grain, hay, and silage and mark an official judging score card.

Conclusions:

Discuss how the ability to evaluate and rank samples of grain can improve a student's SAEP.

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Identifying Career Opportunities in Plant and Soil Science

RELATED PROBLEM AREAS:

1. Identifying Careers in Agriculture/Horticulture (Central Core Cluster)
2. Gaining Employment in an Agricultural Occupation (Central Core Cluster)
3. Identifying Career Opportunities in Agribusiness Management
4. Identifying Career Opportunities in Animal Science
5. Identifying Career Opportunities in Food Science
6. Identifying Career Opportunities in Agricultural Engineering/Mechanization

PREREQUISITE PROBLEM AREA(S):

1. Identifying Careers in Agriculture/Horticulture (Central Core Cluster)

LEVEL: Preparatory

OCCUPATIONAL TASKS ADDRESSED:

Agricultural Business and Management Cluster

Duty R: Applying Safety Practices

1. Comply with shop and equipment safety rules
2. Apply basic emergency first-aid techniques
3. Complete accident report
4. Inspect work area and equipment for safe working environment
5. Use fire extinguisher
6. Correct safety hazards
7. Demonstrate cardiopulmonary resuscitation (CPR) techniques
8. Comply with safety requirements for working around automated systems
9. Participate in safety training program

STATE GOALS FOR LEARNING:

In planning the instruction for this problem area, teachers can promote the development of several student learning objectives which are related to the State Goals for Learning in Biological and Physical Sciences and Social Sciences. These objectives are listed on the Learning Assessment Plan forms included on the following page(s). Those learning objectives marked with an asterisk (*) are taken from the sample lists provided by the Illinois State Board of Education.

Illinois Agricultural Core Curriculum

Agricultural Education 124 Mumford Hall 1301 W. Gregory Drive University of Illinois Urbana, IL 61801

Director: Dale A. Law, Ed.D.
Principal Investigator: Jerry D. Pepple, Ed.D.
Research Assistant: Randy J. Bernhardt

1205

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date ________________
☐ Original submission ☐ Revision
Page ____ of ____

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☒ Sciences ☐ Physical Development/Health

(Affix label or complete district information.)

COUNTY	DISTRICT	ESC

District Name

City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will have a working knowledge of the social and environmental implications and limitations of technological development.

Contact Person: ________________
Title: ________________
Phone: ( )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Identify careers in which scientific training is important.					
*2. Identify future vocations in science.					
1206					1207

ISBE 41-78 (1/88)

Submission Date ____________

☐ **Original submission** ☐ **Revision**

Page ____ of ____

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)

COUNTY	DISTRICT	ESC

District Name

City

I. LEARNING AREA *(check one)*

☐ Language Arts
☐ Mathematics
☐ Sciences
☐ Fine Arts
☒ Social Sciences
☐ Physical Development/Health

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to apply the skills and knowledge gained in the social sciences to decision making in life situations.

Contact Person: ____________
Title: ____________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Understand the education and training required to prepare youth and adults for work.					

ISBE 41-78 (1/88)

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Identifying Career Opportunities in Plant and Soil Science

STUDENT LEARNING OBJECTIVES

Upon completion of their study of this problem area, students will be able to:

1. Define terms integral to plant and soil science.
2. Explain the importance of agronomy, and identify areas within agronomy which provide potential career opportunities.
3. Describe the education and training necessary for careers in the agronomic sciences.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Identifying Career Opportunities in Plant and Soil Science

PROBLEMS AND QUESTIONS FOR STUDY **INSTRUCTOR'S NOTES AND REFERENCES**

1. What are some of the careers in the field of Plant and Soil Science?
2. Can you describe what their job duties entail?
3. What are the agronomic sciences?
4. Why is the field of agronomy important?
5. What are the opportunities for employment in the agronomic sciences?
6. How does one prepare for a career in the agronomic sciences?
7. Select a specific career in Plant and Soil Science. What are the educational requirements? What are the prospects for future employment? What are the duties of the job? What are the working conditions? What is the pay range?

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Identifying Career Opportunities in Plant and Soil Science

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES

1. Begin the problem area with an interest approach which includes an overview of what is to be studied.
2. Define "agronomic sciences." Have students give examples of careers included in the agronomic sciences. List these on the board. Use Information Sheet #1.
3. Using Transparency Master #1, have the students select those careers in Plant and Soil Science with which they are familiar, and have them describe those careers in class.
4. Information Sheet #2 is a listing of universities that offer degrees in Plant and Soil Science and could also provide information on the various careers in the Plant and Soil Science field.
5. Invite individuals that have a career in the field of Plant and Soil Science to the class as guest speakers. Possible resource people include representatives from the Soil and Water Conservation Service, County Extension Office, local Farm Bureau Organization, etc.
6. Discuss the importance of the agronomic sciences. Refer to related instructional materials.
7. Have students complete Student Worksheet #1.
8. Ask students, "Where do you think most of the jobs are available in Plant and Soil Science?" Discuss with the class the five general areas that have the most jobs available in the agronomic sciences.
9. Have students complete Student Worksheet #2.
10. Discuss with students the education and preparation necessary for a career in the agronomic sciences.
11. Refer to *Agriculture in the Twenty-First Century* as an excellent source of information for future directions of the Plant and Soil Science field (see references).
12. Have students conduct a research paper on a specific career in Plant and Soil Science. Their research should answer the following questions: (1) What are the educational requirements? (2) What are the prospects for future employment? (3) What are the duties of the job? (4) What are the working conditions? (5) What is the pay range? Sources of reference materials could include: (1) local or school library, (2) colleges or universities, (3) magazines, books, etc., (4) guidance counselors, and (5) college or university course catalogs or degree program catalogs. Students' findings could be put into a standard research paper, a career poster, or a career "brochure."

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Identifying Career Opportunities in Plant and Soil Science

REFERENCES

INSTRUCTOR'S NOTES AND REFERENCES

*1. *Exploring Careers in Agronomy, Crops, and Soils.* American Society of Agronomy, Crop Science Society of America, and Soil Science Society of America, 677 South Segoe Road, Madison, WI 53711.

*2. *Agriculture in the Twenty-First Century.* (1983). Rosenblum, John W. (ed.). Wiley-Interscience Publication, John Wiley and Sons, Inc., 605 Third Avenue, New York, NY 10158-0012.

3. *Careers in Agribusiness and Industry.* (1980). Stone, Archie A., Stone, Marcella L., Gulvin, Harold E. Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

4. *Exploring Agribusiness.* (1980). Roy, Ewell Paul. Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

5. *Applied Communication.* Curriculum Publications Clearinghouse, Western Illinois University, Horrabin Hall 46, Macomb, IL 61455.

*Indicates highly recommended reference

INSTRUCTIONAL RESOURCES

These resources are intended for use by teachers in planning and teaching the materials for this problem area and may be adapted to fit the teaching method(s) used.

INFORMATION SHEET #1 — Agronomic Sciences Defined

INFORMATION SHEET #2 — Universities and Colleges in the United States

INFORMATION SHEET #3 — Agronomy — Why is it Important?

INFORMATION SHEET #4 — Where Are Most of the Jobs in Agronomy Today?

INFORMATION SHEET #5 — Preparing for a Career in the Agronomic Sciences

TRANSPARENCY MASTER #1 — Career Information

TRANSPARENCY MASTER #2 — Agronomy — Why is it Important?

TRANSPARENCY MASTER #3 — Where Are Most of the Jobs in Agronomy Today?

TRANSPARENCY MASTER #4 — Preparing for a Career in the Agronomic Sciences

INFORMATION SHEET #1

Agronomic Sciences Defined

Agronomy is the development and the practical application of plant and soil sciences to produce abundant, high-quality food, feed, and fiber crops. This process is being carried out with the strict provision of maintaining present environmental standards.

Crop Science relates primarily to the genetics, breeding, physiology, and management of field and turf crops. Crop science also deals with the production of quality seed and the nutritional value of crops.

Soil Science is heavily oriented toward soil physics, soil chemistry, soil origin, soil microbiology, soil mineralogy, soil fertility, and soil management as they apply to the growth of plants. It also concerns itself with soil uses such as foundations for building and road construction, waterways, and waste disposal.

INFORMATION SHEET #2

Universities and Colleges in the United States

Alabama

Alabama A & M University
Normal, AL 35762

Auburn University
Auburn, AL 36849

Tuskegee Institute
Tuskegee Institute, AL 36088

Alaska

University of Alaska
Agricultural Experiment Station
Palmer, AK 99645

Arizona

The University of Arizona
Tucson, AZ 85721

Arizona State University
Tempe, AZ 85281

Arkansas

Southern Arkansas University
Magnolia, AR 71753

University of Arkansas
Fayetteville, AR 72701

University of Arkansas
Monticello, AR 71655

University of Arkansas
Pine Bluff, AR 71601

California

California Polytechnic State University
San Luis Obispo, CA 93407

California State Polytechnic University
Pomona, CA 91768

California State University
Chico, CA 95926

California State University
Fresno, CA 93740

Humboldt State University
Arcata, CA 95521

University of California
Davis, CA 95616

University of California
Riverside, CA 92521

Colorado

Colorado State University
Fort Collins, CO 80523

Fort Lewis College
Durango, CO 81301

Connecticut

The University of Connecticut
Storrs, CT 06268

Delaware

Delaware State College
Dover, DE 19901

University of Delaware
Newark, DE 19711

Florida

Florida Southern College
Lakeland, FL 33801

University of Florida
Gainesville, FL 32611

Georgia

Abraham Baldwin Agriculture College
Tifton, GA 31794

Berry College
Mount Berry, GA 30149

Fort Valley State College
Fort Valley, GA 31030

University of Georgia
Athens, GA 30602

Hawaii

University of Hawaii
Honolulu, HI 96822

Idaho

College of South Idaho
Twin Falls, ID 83301

Ricks College
Rexburg, ID 83440

University of Idaho
Moscow, ID 83843

Illinois

Illinois State University
Normal, IL 61761

Southern Illinois University
Carbondale, IL 62901

University of Illinois
Urbana, IL 61801

Western Illinois University
Macomb, IL 61455

Indiana

Purdue University
West Lafayette, IN 47907

Iowa

Iowa State University
Ames, IA 50011

Kansas

Fort Hays State University
Hays, KS 67601

Kansas State University
Manhattan, KS 66506

McPherson College
McPherson, KS 67460

Kentucky

Morehead State University
Morehead, KY 40351

Murray State University
Murray, KY 42071

University of Kentucky
Lexington, KY 40506

Western Kentucky University
Bowling Green, KY 42101

Louisiana

Louisiana State University
Baton Rouge, LA 70803

Louisiana Tech University
Ruston, LA 71272

McNeese State University
Lake Charles, LA 70609

Nicholls State University
Thibodaux, LA 70310

Northeast Louisiana University
Monroe, LA 71209

Northwestern State University
Natchitoches, LA 71497

Southeastern Louisiana
University
Hammond, LA 70402

Southern University
Baton Rouge, LA 70813

University of Southwestern
Louisiana
Lafayette, LA 70504

Maine

University of Maine
Orono, ME 04469

Maryland

University of Maryland
College Park, MD 20742

University of Maryland
Princess Anne, MD 21853

Massachusetts

University of Massachusetts
Amherst, MA 01003

Michigan

Michigan State University
East Lansing, MI 48824

Michigan Technological
University
Hancock, MI 49930

Northern Michigan University
Marquette, MI 49855

Minnesota

University of Minnesota
St. Paul, MN 55108

University of Minnesota
Technical College
Crookston, MN 56716

University of Minnesota
Technical College
Waseca, MN 56093

Mississippi

Alcorn State University
Lorman, MS 39096

Mississippi State University
Mississippi State, MS 39762

Missouri

Central Missouri State
University
Warrensburg, MO 64093

Lincoln University
Jefferson City, MO 65101

Missouri Western State College
St. Joseph, MO 64507

Northeast Missouri State
University
Kirksville, MO 63501

Northeast Missouri State
University
Maryville, MO 64468

Southwest Missouri State
University
Springfield, MO 65802

University of Missouri
Columbia, MO 65211

Montana

Montana State University
Bozeman, MT 59717

Northern Montana College
Havre, MT 59501

Nebraska

University of Nebraska
Lincoln, NE 68583

Nevada

University of Nevada
Reno, NV 89557

New Hampshire

University of New Hampshire
Durham, NH 03824

New Jersey

Rutgers University
New Brunswick, NJ 08903

New Mexico

New Mexico State University
Las Cruces, NM 88003

New York

Cornell University
Ithaca, NY 14853

North Carolina

North Carolina A & T State
University
Greensboro, NC 27411

North Carolina State University
Raleigh, NC 27650

North Dakota

North Dakota State University
Fargo, ND 58105

Ohio

The Ohio State University
Columbus, OH 43210

Wilmington College
Wilmington, OH 45177

Oklahoma

Cameron University
Lawton, OK 73505

Langston University
Langston, OK 73050

Oklahoma Panhandle State
University
Goodwell, OK 73939

Oklahoma State University
Stillwater, OK 74074

Oregon

Oregon State University
Corvallis, OR 97331

Pennsylvania

Delaware Valley College of
Science and Agriculture
Doylestown, PA 18901

The Pennsylvania State
University
University Park, PA 16802

Temple University
Ambler, PA 19002

Puerto Rico

University of Puerto Rico
Mayaguez, PR 00708

University of Puerto Rico
Rio Piedras, PR 00928

Rhode Island

University of Rhode Island
Kingston, RI 02881

South Carolina

Clemson University
Clemson, SC 29631

South Dakota

South Dakota State University
Brookings, SD 57007

Tennessee

Austin Peay State University
Clarksville, TN 37040

Middle Tennessee State
University
Murfreesboro, TN 37130

Tennessee Technological
University
Cookeville, TN 38505

University of Tennessee
Knoxville, TN 37901

University of Tennessee
Martin, TN 38238

Texas

Abilene Christian University
Abilene, TX 79601

East Texas State University
Commerce, TX 75428

Prairie View A & M University
Prairie View, TX 77445

Sam Houston State University
Huntsville, TX 77341

Southwest Texas State
University
San Marcos, TX 78666

Stephen F. Austin State
University
Nacogdoches, TX 75962

Texas A & I University
Kingsville, TX 78363

Texas A & M University
College Station, TX 77843

Texas Tech University
Lubbock, TX 79409

West Texas State University
Canyon, TX 79015

Utah

Brigham Young University
Provo, UT 84602

Utah State University
Logan, UT 84322

Vermont

University of Vermont
Burlington, VT 05405

Virginia

Old Dominion University
Norfolk, VA 23508

Virginia Polytechnic Institute
and State University
Blacksburg, VA 24061

Virginia State College
Petersburg, VA 23806

Washington

University of Washington
Seattle, WA 98195

Washington State University
Pullman, WA 99164

West Virginia

West Virginia University
Morgantown, WV 26506

Wisconsin

University of Wisconsin
Green Bay, WI 54302

University of Wisconsin
Madison, WI 53706

University of Wisconsin
Platteville, WI 53818

University of Wisconsin
River Falls, WI 54022

University of Wisconsin
Stevens Point, WI 54481

Wyoming

University of Wyoming
Laramie, WY 82071

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IINFORMATION SHEET #3

Agronomy — Why is it Important?

A career in agronomy will keep you in the center of scientific efforts to increase the supply of high-quality food, feed, and fiber crops.

Food shortages exist in many places throughout the world. And even though the United States is the world's leading food exporter, food shortages still exist in many parts of this country as well. Therefore, an important challenge lying ahead for agronomists is the problem of increasing food production at home and abroad while using our limited food-production resources more efficiently.

Genetic engineering may be able to move single genes between species either through somatic cell hybridization or through genetic transfer of specific gene segments between species.

Plant breeders will need to develop more insect- or disease-resistant cultivars. They may also develop crops that use sunlight, water, or minerals more efficiently.

Agronomists work with the effects of environmental pollution, pesticides, other toxic chemicals, soil conservation, etc.

INFORMATION SHEET #4

Where Are Most of the Jobs in Agronomy Today?

1. Research and Development — This is the foundation of scientific advancement in fertilizers, pesticides, and seeds. The key to continued growth is product and crop management research.

2. Customer-oriented Agribusiness Firms — These firms respond to the agriculturist's need for product and management information, and play a pivotal role of liaison between the agriculturist and the company.

3. Sales — Numerous agronomy graduates are involved in the sale of the agricultural products which are so vital to today's economy. Agriculture needs competent, technically oriented sales staffs to get merchandise to agriculturists and to recommend new technology to the customer. One can easily move from sales into other fields such as advertising, marketing, technical service, administration, or management of the sales firm.

4. Consulting Services — Professional consulting services are offering additional job opportunities to an increasing number of agronomy graduates. Agronomists join with experts in other technical areas to advise agriculturists on a contract basis.

5. Farmers, Ranchers, and Agriculturists — An increasing number of agronomy graduates have become farmers or ranchers, using their college training for the actual production of food and fiber crops. Farming is a complex business and these graduates find an agronomy degree to be very beneficial.

6. Miscellaneous — Other agronomists serve as managers of farms, bank loan specialists, and golf course or forest superintendents. Top administrative positions in industry and public agencies are also available.

INFORMATION SHEET #5

Preparing for a Career in the Agronomic Sciences

1. Background — Agronomists are men and women with many types of backgrounds from both urban and rural areas. Many agronomy graduates have no farm background whatsoever.

2. High School Education

    A. Agriculture — A foundation of courses which address the basic agronomic science principles is desirable.
    B. Science — Become familiar with the basic tools of science—biology, chemistry, mathematics, and physics.
    C. English — A strong knowledge of our native language is imperative.
    D. Foreign Languages — Experience with other languages is beneficial if overseas work is desired.

3. College Education

    A. Basics — English, Math, Biology and Natural Sciences, etc., should be studied.
    B. Expansion of Basic Sciences — Further coursework should be taken in those sciences studied in high school.
    C. Advanced Sciences — Courses should be taken in some of the advanced sciences, including geology, botany, microbiology, genetics, plant pathology, soil chemistry, plant physiology, entomology, biochemistry, meteorology, and other applied sciences.

4. Advanced Degrees — Numerous positions in teaching, research, or extension require training beyond the bachelor's degree.

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TRANSPARENCY MASTER #1

Career Information

The following list of careers is taken from an American Society of Agronomy, Crop Science Society of America, and Soil Science Society of America publication.

Administrator
Agricultural Climatologist
Agronomist
Conservation Agronomist
County Agent
Crop Biochemist
Crop Breeder
Crop Chemist
Crop Cytogeneticist
Crop Cytologist
Crop Ecologist
Crop Geneticist
Land Use Specialist
Pedologist
Plant Biochemist
Plant Breeder
Plant Chemist
Plant Cytogeneticist
Plant Cytologist
Plant Ecologist
Plant Geneticist
Plant Physiologist
Range Management Specialist
Range Soil Scientist
Reclamation Specialist
Resource Conservationist
Seed Production Specialist
Seed Technologist
Soil and Water Conservationist
Soil and Water Management Specialist
Soil and Water Specialist
Soil Biochemist
Soil Chemist
Crop Marketing Specialist
Crop Physiologist
Crop Production Specialist
Crop Protection Specialist
Crop Quality Specialist
Crop Scientist
Crop Specialist
Crop Utilization Specialist
District Conservationist
Edaphologist
Erosion and Sediment Control Specialist
Fertilizer Technologist
Fertilizer Technology Specialist

Fertilizer Use Specialist
Forest Soil Scientist
Forest Soil Specialist
Forester
Geneticist
Irrigation Specialist
Irrigationist
Land Management Specialist
Soil Classifier
Soil Conservationist
Soil Fertility Specialist
Soil Genesis Specialist
Soil Interpretation Specialist
Soil Management Specialist
Soil Microbiologist
Soil Mineralogist
Soil Morphologist
Soil Physicist
Soil Resource Specialist
Soil Scientist
Soil Specialist
Soil-Plant Analyst
Soil-Plant Nutrition Specialist
Soil-Water-Plant Specialist
Station Superintendent
Statistician
Surface Mine Reclamation Specialist
Turfgrass Manager
Turfgrass Specialist
Weed Scientist

TRANSPARENCY MASTER #2

Agronomy — Why is it Important?

1. Introduction
2. Genetic Engineering
3. Plant Breeding
4. Agronomic Science Concerns

TRANSPARENCY MASTER #3

Where Are Most of the Jobs in Agronomy Today?

1. Research and Development
2. Customer-oriented Agribusiness Firms
3. Sales
4. Consulting Services
5. Farmers, Ranchers, and Agriculturists
6. Miscellaneous

TRANSPARENCY MASTER #4

Preparing for a Career in the Agronomic Sciences

1. Background
2. High School Education
   A. Agriculture
   B. Science
   C. English
   D. Foreign Languages
3. College
   A. Basics
   B. Expansion of Basic Sciences
   C. Advanced Sciences
4. Advanced College Degrees

STUDENT ACTIVITIES

STUDENT WORKSHEET #1 — Careers in Agronomic Science Word Search

STUDENT WORKSHEET #2 — Where Are Most of the Jobs in Agronomy Today?

For additional activities, teachers may refer to the "Suggested Teaching Activities and Procedures" section in the Instructor's Guide.

STUDENT WORKSHEET #1

Careers in Agronomic Science Word Search

C	Q	Q	Y	Q	G	L	X	X	O	L	I	T	M	T	K	M	U	Q	M
S	X	J	K	P	H	Y	S	I	C	S	S	R	S	X	R	U	E	X	O
B	T	R	F	H	E	R	W	J	C	I	A	I	R	L	J	C	S	I	R
P	L	E	Y	M	G	L	F	B	G	S	L	Q	L	F	N	I	W	C	T
L	M	S	R	Z	H	S	T	O	T	A	L	D	Y	E	U	D	G	V	P
I	I	E	G	A	X	B	L	S	I	A	R	R	I	J	E	T	F	G	Z
J	N	A	C	M	T	O	I	C	E	Z	S	C	N	D	S	I	U	D	F
J	I	R	E	O	C	T	E	C	L	T	S	C	E	V	B	W	D	R	M
I	Q	C	B	E	N	P	B	P	H	D	S	E	A	E	X	S	N	J	E
Q	H	H	E	E	S	S	N	C	N	A	F	I	R	R	O	X	G	K	G
X	R	W	I	Y	Y	C	E	Y	N	A	L	C	M	I	E	V	U	L	E
S	W	C	G	X	R	M	E	R	G	N	H	L	L	E	K	E	N	P	Z
E	S	X	R	O	J	L	O	R	V	E	F	S	E	O	H	P	R	H	B
W	B	U	P	D	I	B	O	N	M	A	B	U	C	N	G	C	U	S	Q
F	T	S	J	B	P	N	R	I	O	K	T	S	T	I	G	H	O	M	T
U	W	E	S	C	O	Q	S	B	V	R	T	I	Z	F	T	I	Y	I	Y
A	T	S	R	M	B	T	X	R	Z	F	G	V	O	W	C	E	N	Y	B
N	M	Q	I	J	R	E	R	M	O	O	Q	A	N	N	R	F	N	G	G
E	Q	S	V	Y	E	L	C	O	C	V	H	B	S	Q	X	F	M	E	Y
R	T	M	K	C	O	W	D	J	E	X	M	T	K	E	Y	Q	H	F	G

All of the words in this puzzle are related to an exciting career in agronomic science.

Agronomist
Agronomy
Biochemist
Careers
Challenging
Chemistry
Conservation
Crops
Ecologist
Feed
Fiber
Food
Future
Genetics
Physics
Research
Science
Scientists
Soils
Specialist

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STUDENT WORKSHEET #1 — Key

Careers in Agronomic Science Word Search

• • • • • • • • • • • • T • T • • • • •
• • • • P H Y S I C S S • S • • • E • •
• • R • • • • • • • I • I • • • C • • •
• • E • • • • • • G S L . . F N • • • •
• • S • • . • • O T A • • • E U • • • •
• • E • • • • L S I • • • I • • T F • •
• • A C • • O I C • • • C • D • I U • •
• • R • O C T E C • T S C E • B • • R •
• • C • E N P • • H • S E A E • S • • E
• • H • E S S • • • A F I R R O • • • •
• • • I • Y C E • • A L C M I E • • • •
• • C • • R M • R G • H L L E • E • • •
• S • • O • • O R V E • S E • H • R • •
• • • P • • • O N M A • • C N • C • S •
• • S • • • N • I O • T • • I G • O • •
• • • • • O • S • • R • I . . T I • I •
• • • • M • T • • • F G • O • • E N • B
• • • I • R • • • O • • A • N • • N G •
• • S • Y • • • O • • • • • • • • • E •
• T • • • • • D • • • • • • • • • • • G

All of the words in this puzzle are related to an exciting career in agronomic science.

Agronomist
Agronomy
Biochemist
Careers
Challenging
Chemistry
Conservation
Crops
Ecologist
Feed
Fiber
Food
Future
Genetics
Physics
Research
Science
Scientists
Soils
Specialist

STUDENT WORKSHEET #2

Where Are Most of the Jobs in Agronomy Today?

Match the job titles in the left column with the correct description in the right column.

1. ________ Farmers, Ranchers, and Agriculturists
2. ________ Research and Development
3. ________ Miscellaneous
4. ________ Consulting Services
5. ________ Customer-oriented Agribusiness Firms
6. ________ Sales

A. This is the foundation of scientific advancement.

B. Respond to agriculturist's needs for product and management information.

C. Competent, technically oriented staff to get merchandise to agriculturists and customers.

D. Join with other experts in other areas to advise agriculturists.

E. More and more agronomists are using their training to run this complex business.

F. Managers of farms, bank loan specialists, golf course superintendents, forest superintendents, administrators in industry and public agencies.

STUDENT WORKSHEET #2 — Key

Where Are Most of the Jobs in Agronomy Today?

Match the job titles in the left column with the correct description in the right column.

1. *E* Farmers, Ranchers, and Agriculturists
2. *A* Research and Development
3. *F* Miscellaneous
4. *D* Consulting Services
5. *B* Customer-oriented Agribusiness Firms
6. *C* Sales

A. This is the foundation of scientific advancement.

B. Respond to agriculturist's needs for product and management information.

C. Competent, technically oriented staff to get merchandise to agriculturists and customers.

D. Join with other experts in other areas to advise agriculturists.

E. More and more agronomists are using their training to run this complex business.

F. Managers of farms, bank loan specialists, golf course superintendents, forest superintendents, administrators in industry and public agencies.

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Identifying Alternative Crop Production Systems

RELATED PROBLEM AREAS:

1. Growing Vegetables (Horticulture Cluster)
2. Understanding Plant Germination, Growth, and Development (Horticulture Cluster)
3. Growing Ornamental Plants (Horticulture Cluster)
4. Understanding Plant Anatomy and Physiology (Horticulture Cluster)
5. Designing Silk and Dried Arrangements (Horticulture Cluster)
6. Developing Growing Media (Horticulture Cluster)

PREREQUISITE PROBLEM AREA(S): None

LEVEL: Orientation

OCCUPATIONAL TASKS ADDRESSED:

Horticulture Cluster

Duty A: Propagating Plants, Seedlings, and Cuttings

1. Plant seed in flats or growing benches
2. Prepare plants and cuttings for propagation
3. Take cuttings
4. Apply rooting hormone

Duty E: Harvesting Plants

1. Harvest seed
2. Dig bulbs and corms

Duty J: Designing/Landscaping

1. Select plants
2. Design landscape plan/paper and pencil

Duty S: Design Arrangements

1. Design artificial flower and foliage arrangements

Duty B: Preparing Soils and Planting Media for Mushrooms

1. Mix media materials
2. Pasteurize prepared media (steam)
3. Prepare seed sheet

STATE GOALS FOR LEARNING:

In planning the instruction for this problem area, teachers can promote the development of several student learning objectives which are related to the State Goals for Learning in the Biological and Physical Sciences. These objectives are listed on the Learning Assessment Plan forms included on the following page(s). Those learning objectives marked with an asterisk (*) are taken from the sample lists provided by the Illinois State Board of Education.

Illinois Agricultural Core Curriculum
Agricultural Education 124 Mumford Hall 1301 W. Gregory Drive University of Illinois Urbana, IL 61801

Director: Dale A. Law, Ed.D.
Principal Investigator: Jerry D. Pepple, Ed.D.
Research Assistant: Janis L. Anderson

Submission Date ____________________
☐ Original submission ☐ Revision
Page ____ of ____

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)

COUNTY	DISTRICT	ESC

District Name
City

I. LEARNING AREA *(check one)*

☐ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☒ Sciences ☐ Physical Development/Health

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will have a working knowledge of the concepts and basic vocabulary of biological, physical, and environmental sciences and their application to life and work in contemporary technological society

Contact Person: ____________________
Title: ____________________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Relate the processes by which organisms capture, utilize, and release energy. *2. Predict how chemical equilibrium will change when different stresses are applied to the system, each independent of the other.					
*3. Recognize and compare major cell processes such as respiration, protein synthesis, and photosynthesis.					
*4. Recognize that all organisms exhibit responses to stimuli.					
*5. Relate a general understanding of gravity.					
*6. Compare processes by which matter and energy are transported throughout an organism.					
*7. Identify the components necessary for a community to exist and survive.					
8. Explain the process of growing mushrooms.					
9. Grow herbs according to their requirements.					

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1234

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Submission Date ____________

☐ Original submission ☐ Revision

Page ____ of ____

I. LEARNING AREA *(check one)*

☐ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☒ Sciences ☐ Physical Development/Health

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)

COUNTY	DISTRICT	ESC

District Name

City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will have a working knowledge of the processes, techniques, methods, equipment, and available technology of science.

Contact Person: ____________
Title: ____________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Analyze the results of an experiment.					

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Submission Date ________________

☐ Original submission ☐ Revision

Page ____ of ____

I. LEARNING AREA *(check one)*

☐ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☒ Sciences ☐ Physical Development/Health

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)

COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐

District Name

City

Contact Person: ________________
Title: ________________
Phone: (   )

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will have a working knowledge of the social and environmental implications and limitations of technological development.

III. LEARNING OBJECTIVES

By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:

III. LEARNING OBJECTIVES	IV. ASSESSMENT A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	V. EXPECTATIONS Percent of Students Expected to Achieve Objective
*1. Identify areas of current scientific research that may evolve as technological development.					
*2. Understand the impact of technological developments on society.					
3. Identify reasons why alternative crops are needed.					

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INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Identifying Alternative Crop Production Systems

STUDENT LEARNING OBJECTIVES

Upon completion of their study of this problem area, students will be able to:

1. Know and explain the parts of the mushroom.
2. Understand the history of mushroom cultivation.
3. Explain the process of growing mushrooms.
4. Know the various mediums used in mushroom cultivation.
5. Identify herbs and their contributions, including flavor, fragrance, or medicinal use.
6. Grow herbs according to their requirements.
7. Place herbs in a landscape design.
8 Harvest, dry, and store herbs.
9. Identify herbs used in everyday products.
10. Identify other alternate crops for production.
11. Identify reasons why alternative crops are needed.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Identifying Alternative Crop Production Systems

PROBLEMS AND QUESTIONS FOR STUDY	INSTRUCTOR'S NOTES AND REFERENCES
1. What are the parts of a mushroom?	
2. How can mushrooms be preserved?	
3. How are edible mushrooms grown?	
4. What is compost?	
5. What are the stages of mushroom growth?	
6. How can mushrooms be reproduced?	
7. In what ways are herbs used today?	
8. How are herbs dried and stored?	
9. How can herbs enhance a landscape?	
10. Which herbs are used most for cooking?	
11. What herbs are used in dried or fresh floral arrangements?	
12. How are herbs still used for medicinal purposes?	
13. How are herbs propagated?	
14. What are some products that use herbs?	
15. How are herbs used to dye materials?	
16. Name six reasons why there is a need for alternative crops.	

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Identifying Alternative Crop Production Systems

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES

1. Grow some mushrooms as a class project. Supplies for this project can be purchased from Carolina Biological Supply Company (see references). The supplies include:
    a. Mushroom Farm-in-a-box — a complete kit which will produce a mushroom crop in about 30 days.
    b. Mushroom Study BioKit — a kit used to observe and study the growth and development, environmental requirements, and microscopic structures of mushrooms.
    c. Fungi Chart — forty color pictures with scientific names.

2. Do experiment on growing mushrooms in various media.

3. Take the class on a mushroom collecting trip. Identify the specimens collected either in the field or after they have been brought back to school. Project can be continued with a discussion of which samples are edible and which are not, how mushrooms grow, and the setting in which mushrooms grow.

4. Visit a mushroom farm to see firsthand how they are produced, harvested and packaged. Be sure to discuss varieties and grade.

5. Have students research products to find how herbs are used in products.

6. Grow some herbs in the greenhouse. Harvest, dry, and store them. This project might be an idea for a fund raiser.

7. Have class create landscape designs that include herbs.

8. Grow herbs in the greenhouse for use in floral design arrangements.

9. Growing herbs might be a good SAE project that students can do in the greenhouse or at home.

10. Have the class propagate herbs and collect seeds. Collection can be sold or used next year.

11. Have students complete Student Worksheet #1.

12. Use Student Worksheet #2 to have students assess an area at home. Have them determine where to plant and what herbs to plant.

13. Have students research some new crops and determine the usefulness of those crops.

14. Have students grow some *chondrus crispus* in a tank in the classroom.

INSTRUCTOR'S NOTES AND REFERENCES

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INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Plant and Soil Science

PROBLEM AREA: Identifying Alternative Crop Production Systems

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*Indicates highly recommended reference

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTIONAL RESOURCES

These resources are intended for use by teachers in planning and teaching the materials for this problem area and may be adapted to fit the teaching method(s) used.

INFORMATION SHEET #1 — Growing Process (with Tables)

INFORMATION SHEET #2 — Compost

INFORMATION SHEET #3 — Terms to be Defined

INFORMATION SHEET #4 — Preserving Mushrooms

INFORMATION SHEET #5 — Herb List

INFORMATION SHEET #6 — Drying and Storing Herbs

INFORMATION SHEET #7 — Garden Design (with Tables)

INFORMATION SHEET #8 — Propagating Herbs

INFORMATION SHEET #9 — Herb Dyes

INFORMATION SHEET #10 — Herb Products

INFORMATION SHEET #11 — Herbs Used in Commerce and Industry

INFORMATION SHEET #12 — Herbs Useful in Flower Arrangements

INFORMATION SHEET #13 — Why a Need for New Crops?

INFORMATION SHEET #14 — Selected New Crops

TRANSPARENCY MASTER #1 — Parts of a Mushroom and the Life Cycle of a Mushroom

TRANSPARENCY MASTER #2 — Why a Need for New Crops?

TRANSPARENCY MASTER #3 — Selected New Crops

INFORMATION SHEET #1

Growing Process

1. Mushrooms can be grown in:

   a. Mushroom houses.

   b. Sheds, cellars, stables.

   c. Deep caves.

   d. Gardens/fields or prepared beds.

2. The lamellae (gills) produce a powderlike substance containing microscopic spores. Some spores that fall to the soil will germinate under the right conditions. These spores form threadlike structures.

   Male and female primary mycelium need to come together to produce a secondary mycelium which will in turn produce fruiting bodies. They can also reproduce through asexual spores called conidia formed on the mycelium. They germinate forming a secondary mycelium or they can reproduce from pieces of mycelium that have been separated from the parent fungi.

3. Growing mushrooms is the only economically profitable biotechnology process for the conversion of waste plant residues (lignocellulose). The process involves:

   a. Preparation and production of media.

   b. Inoculation of media with propagules of the fungus, growth of mycelium, fruiting and harvesting.

4. The growing process consists of two steps:

   a. Composting

      1) Phase I:

         a) The mixing and wetting of the straw and/or manure into stacks. Mixing (turning) of stacks is done at intervals of 2 to 4 days. This phase takes 7 to 14 days.

         b) Goal of Phase I is to get compost to have the correct water content and to be sure that all ingredients are mixed well so that it will start heating up.

         NOTE: During the wetting be sure to recirculate liquid runoff to reduce nutrient loss. The water content is 72% in horse manure and 75% in straw-based compost. Each stack is 1.8 to 2.0 m high and wide. Be sure stacks are even. Mix additives early in the process. Additives should be readily available, with little variation in quality, and be pure in a dry form.

         c) To assess the compost in Phase I use:

            (1) Squeeze test — Take a handful of compost and squeeze. If the liquid runs through the fingers there is too much water. If it just moistens the hand it is correct. If it is barely damp it is too dry.

            (2) Twist test — Grip a lump of compost with both hands and twist in opposite directions. If it twists apart easily you are approaching the end of the composting (Phase II).

            (3) Thumb and finger test — Rub compost between the thumb and forefinger. If it is greasy then gypsum needs to be added.

            (4) Color test — Observe compost. It should continue to become darker and more uniform in color.

            (5) Smell test — Smell compost to detect the presence of ammonia.

      2) Phase II:

         a) Transfer compost into a controlled room for pasteurization. Pasteurize at 140°F for six hours. Do not mix. Complete composting at 120° to 130°F. This takes 4 to 8 days. Drop temperature to 85°F to insure dormancy of competitors. Microorganisms have started to run out of food, and lowering the temperature allows for mushroom growth with little competition.

         b) Goal of Phase II is to complete the composting and pasteurization.

b. Growth

1) Spawning — inoculation of medium. Spawn today is usually prepared commercially to insure that compost is inoculated at the proper time. Mycelium is grown on sterilized cereal grains such as wheat, rye, and millet. The four main groups of spawn are: smooth or pure white, rough or off-white, cream, and brown.

2) Spawn-run — colonization of mycelium. This stage takes 10 to 14 days at 75°F. Spawn-running is the period of time when mycelium starts to spread. While it spreads it produces enzymes which are passed out into the compost. These enzymes will digest parts of the compost. The products of this digestion are then re-absorbed to provide food and energy. Early growth of fine hairlike threads in the compost begins to change color from dark to reddish brown. At the end of this stage there should be no dark brown compost showing.

3) Casing — covering of mycelium. Cover colonized mycelium with a layer of peat/chalk mixture or soil at 64° to 68°F. Casing layer is responsible for the initiation of fruiting bodies. The casing layer also functions to remove one or more self-inhibitors which keep the mycelium in the vegetative stage.

4) Precropping — continued colonization. Initiation and development of fruiting bodies occurs at 60° to 68°F. This process takes 18 to 21 days. Mycelial growth and fruiting can be regulated by temperature, gaseous environment, nutrients, water activity, and light. Production of fruiting bodies requires either sexual or asexual reproduction.

5) Cropping — harvesting. A maximum of five flushes are harvested at 7 to 10 day intervals. Cropping as a whole takes 30 to 35 days at 60° to 65°F. Cropping occurs in a series of cycles called flushes. Commercially, only 4 or 5 flushes are harvested due to the decrease in amount of mushrooms at each cycle.

6) Cookout — steam-treating of the growth chambers at a temperature of 140°F or greater for 1 to 2 days.

7) Emptying — removal of compost. Growth chambers are cleaned.

NOTE: The whole process takes 73 to 99 days.

5. The "Cooling Process" occurs after harvest. The mushrooms need to be cooled for shipment and storage. If large amounts of mushrooms are put in cold storage directly after harvest with no prior cooling, the mushrooms on the edges of the stacks will cool properly. However, those in the center of the stacks may continue to heat up for some time. In order to assure even cooling of the stack, a prior cooling should be done before mushrooms go into cold storage. For every 10°F of cooling, there is a one percent loss of weight.

The types of cooling are "cool-chain" or vacuum cooling. Commercially, mushrooms need to be cooled to 45.5°F. Those mushrooms cooled by the vacuum process lose an average of 19% of weight as compared to 7% lost by conventional means.

INFORMATION SHEET #1 (con't.)

Table A
Growth Substrates and Production Cycle Time for Cultivation of Edible Fungi

Species	Substrate	Production cycle time or season
Agaricus bisporus/bitorwuis	Composted straw	12-14 weeks
Lentinus edodes	(a) Wood logs of broad-leaved trees (b) Sterilized sawdust/rice bran	Spring/autumn (3-6 years) 6-8 months
Volvariella volvacea	(a) Fermented rice straw (b) Composted cotton waste	7-10 weeks 5-6 weeks
Flammulina velutipes	(a) Sterilized sawdust/rice-bran mixtures	12-20 weeks
Pleurotus spp.	(a) Pasteurized straw (b) Fermented straw mixtures	8-12 weeks
Pholiota nameko spp.	(a) Sterilized sawdust/rice-bran mixtures (b) Wood logs of deciduous trees	8-10 weeks June/July or Sept/Nov depending on species
Auricularia spp.	(a) Wood logs (b) Sterilized sawdust/rice-bran mixtures	Spring/autumn (3-6 years)
Tremellafuciformis	Wood logs (hardwood trees)	7 months/year 3-6 years

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Table B
Types of Medium Preparation and Utilization for Mushroom Cultivation

Assemble substrates
(straws/sawdust/logs)
(nitrogenous materials)
(water)

Compost of steam pretreatment	Nonsterile substrate	Sterile substrate
Cool	Inoculate	Inoculate
Inoculate (spawn)	Mycelial growth	Mycelial growth
Mycelial growth	Fruit body production	Fruit body production
Fruit body production	*Lentinus edodes*	*Flammulina velutipes*
Examples: *Peurotus spp.* *Agaricus bisporus* *Volvariella volvacea* *Peurotus spp.*		

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INFORMATION SHEET #2

Compost

The aim of composting is to produce a medium that will support mushrooms but be unfavorable to their competitors. Two phases of composting are discussed in Information Sheet #1. Compost stacks:

1. Produce heat.
2. Produce compost most efficiently between 120°F and 130°F. However, the center of the stack will be hotter than the outside edges.
3. Need oxygen so microorganisms can heat the stack properly.
4. Need 1.5 - 1.8 percent nitrogen, based on dry matter (dm), in order for microbes to function. Examples of sources of nitrogen include brewer's grain, urea, poultry manure, and ammonium sulphate.
5. Need to be uniform.
6. Need proper proportions of nitrogen (N), manure (M), and additives (A). Weight of A/ Weight of M = %dm of M(desired %N - actual %N of M) + %dm of A (actual %N of A - desired %N).
7. May need gypsum added to rid compost of greasy feel. Gypsum also increases acidity, thereby lessening the smell of the ammonia.
8. Create a "chimney effect" of airflow. As hot air rises through a stack, more air is drawn into the stack from the sides.
9. May be improved by the use of stable manure, which provides anchorage, nutrients, and heat. Because of strong fermentation in the compost when manure is added, some soil can be added to the compost with the manure.
10. May be improved by the use of manure, preferably from horses, or compost additive derived from manure. The manure or additive should be well fermented, of homogeneous texture, and brownish in color, and it should give off little smell.

INFORMATION SHEET #3

Terms to be Defined

Gills — radiating, vertical, platelike structures carrying the hymenium, found on the underside of the caps of the Agaricaceae.

Mycelium — tissue of which mushrooms are made.

Mycology — scientific study of fungi.

Volva — sheathlike cover which envelopes some species in their early development. It survives at the base of the stem as a cupulate remnant or as torn fragments.

INFORMATION SHEET #4

Preserving Mushrooms

To preserve mushrooms in oil:

1. Use unripe or medium-ripe mushrooms.
2. Clean carefully.
3. Cut into large pieces.
4. Boil in water for 2-3 minutes.
5. Boil, in another pot, equal amounts of water and vinegar to which have been added small whole onions, laurel and rosemary leaves, pepper in grains, and salt.
6. Pour whole pot of boiled mushrooms into vinegar solution.
7. Boil for 15 minutes.
8. Drain and place in glass jars.
9. Fill with oil.
10. Seal airtight.

To prepare mushroom extract:

1. Clean mushrooms and discard bruised parts.
2. Cook on low heat with no water.
3. From time to time collect the juice and put in a container.
4. Pour warm water (as much as the juice you collected) over the mushrooms.
5. Repeat until juice appears discolored and loses its fragrance or taste.
6. Put juice on the stove and boil until it becomes concentrated into a thick extract.

INFORMATION SHEET #5

Herb List

Culinary

- Agrimony
- Angelica
- Anise
- Balm
- Basil
- Bay, sweet
- Bene
- Borage
- Burnet
- Calimint
- Calendula
- Caraway
- Chervil
- Chicory
- Chives
- Cicely, sweet
- Coriander
- Cornflower
- Dill
- Fennel
- Feverfew
- Flax
- Garlic, horehound
- Houseleek
- Hyssop
- Lovage
- Marjoram
- Mint
- Mustard
- Nasturtium
- Parsley
- Poppy
- Rose
- Rosemary
- Rue
- Safflower
- Saffron
- Sage
- Samphire
- Savory
- Skirret
- Sorrel
- Tarragon
- Thyme
- Wormwood

Industrial

- Angelica
- Anise
- Balm
- Basil
- Bedstraw
- Bene
- Bergamot
- Calendula
- Caraway
- Chicory
- Cicely, sweet
- Coriander
- Cornflower
- Dill
- Fennel
- Flax
- Hollyhock
- Hyssop
- Indigo
- Lavender
- Lovage
- Madder
- Marjoram
- Mint
- Mustard
- Parsley
- Poppy
- Rose
- Rosemary
- Rue
- Safflower
- Saffron
- Sage
- Speedwell
- Tansy
- Tarragon
- Thyme
- Verbena, lemon
- Woad
- Wormwood
- Yarrow

Medicinal

- Aconite
- Agrimony
- Angelica
- Balm
- Basil
- Bedstraw
- Bene
- Bergamot
- Bugleweed
- Burnet
- Calamint
- Calendula
- Caraway
- Chicory
- Coriander
- Cornflower
- Fennel
- Feverfew
- Foxglove
- Garlic
- Hollyhock
- Houseleek
- Hyssop
- Indigo
- Lavender
- Lovage
- Madder
- Marjoram
- Mint
- Mugwort
- Mustard
- Parsley
- Pennyroyal
- Poppy
- Rose
- Rosemary
- Rue
- Safflower
- Saffron
- Sage
- Snakeroot
- Speedwell
- Tansy
- Tarragon
- Verbena, lemon
- Woad
- Wormwood
- Yarrow

INFORMATION SHEET #6

Drying and Storing Herbs

Harvesting and Drying

You can harvest roots, seeds, leaves, flowers, or whole plants. August is the principal harvest month. Some of the herbs that are harvested at this time are horehound, sage, basil, lemon balm, marjoram, catnip, chervil, tarragon, savory, mints, and thymes. Some are harvested early so that the maximum amount of essential oils can be obtained. Some of the herbs that are harvested early are thyme, sage, and catnip. Some herbs yield two crops a year if one is taken in July and the other in September.

Perennial herbs should be cut 2/3 of the way down the stalk, and annuals should leave at least 3 to 4 inches for a second growth.

Drying Methods

1. Take leaves from stalks and spread a thin layer on drying screens. Do not dry in direct light to preserve the oils. To dry with an oven, put the leaves on a baking sheet and put oven temperature on 250°F, leaving oven door open.
2. Tie stems into small bundles and hang on cords in a well-ventilated room with no sunlight.
3. For mints, parsley, dill, and fennel, strip the leaves; dip them in boiling, salted water until they just wilt; lift them out with a strainer; shake the water off; spread on a mesh sieve; put on baking sheet; put them in the oven with the door open for 5 to 10 minutes; rub the dried leaves through a sieve to powder them; and store in jars (watch for signs of moisture; it may need further drying).
4. Dig roots in the fall and wash thoroughly. Slice or split the roots and spread thin layers on screens. Dry for 3 to 6 weeks. Slices should snap when bent. Store in tightly closed containers.
5. Seed harvest takes place when seeds mature. Some of the herbs whose seeds are harvested are dill, anise, sesame, poppy, and mustard. Spread the seeds on a screen covered with cloth for 7 to 10 days. Store in jars (watch for moisture).
6. Flowers of some herbs can also be dried and used. Some common examples of flowers used are chamomile, lavender, calendula, and safflower.
    a. Chamomile should be collected when in full bloom. Cut off the flower heads and dry on a screen. Rub the flowers through a sieve until the green on the calyx shows.
    b. Lavender should be collected when opened to the middle. Cut in the morning after there is no dew left. Spread on cloth-covered screen. When dry, strip the stalks.
    c. Calendula is collected by removing the orange florets and drying them on screens in the shade. When dry, keep in tightly closed containers.
    d. Florets of safflower and stigmas of saffron are collected in the same way as calendula. When dry, keep in tightly closed containers.
7. Chives and parsley benefit from harvesting of the outer leaves.
8. A general rule of thumb is that it takes 6 to 8 pounds of fresh product to make one pound of dried product. Most herbs are good for 1 to 2 years.
9. Chives, basil, and parsley may be frozen for future use.
10. To make herb vinegars use one (1) quart of white wine cider or malt white cider (better) with four (4) ounces of fresh herbs or two (2) ounces of dried herbs. Especially good herbs to use are french tarragon, basil, chives, and dill. Cover and set aside for 4 to 6 weeks. Adjust this time if necessary. Strain vinegar into clear bottles.

INFORMATION SHEET #7

Garden Design

The steps of garden design are:

1. Choose the site for your garden.
2. Design the garden on paper.
3. Select the desired herbs or mixture of herbs by look, size, and shape.
4. Select the style of garden you wish to use. The garden should blend in with the landscape of your house.
    a. Formal — balanced with geometric figures such as circles, squares, ovals, or triangles.
    b. Informal — flowing groups (ground covers see table B, crevice fillers see table C).
5. Keep edging low. Use the following herbs:
    a. Herbs for hard boundaries, such as bugleweed (see Table A).
    b. Gray herbs, such as beech and wormwood.
    c. Herbs for edging, such as thyme, winter savory, germander, and chives.
    d. Herbs for precise edges, such as bush basil and American pennyroyal.
    e. Herbs for hedges, such as rosemary, lavender, hyssop, rue, southernwood, and gray santolina (see Table D).
    f. Herbs for behind the border, such as white mugwort, wild senna, lovage, angelica, elecampane, red bergamot, and other tall plants (see Table E).
    g. Blue herbs, such as larkspur, aconite, chicory, clue-flowered hyssop, speedwell, and cornflower (see Table F).
    h. Orange herbs, such as elecampane, butterflyweed, and tansy (see Table F).
    i. Red herbs, such as red bergamot and red yarrow (see Table F).
    j. Mints, such as peppermint, hollymint, curly mint, spearmint, orange mint, and striped-golden water mint.
    k. Spreading herbs, including myrtle, lily-of-the-valley, sweet woodruff, and bugleweed for shady areas; and caraway, thyme, lemon thyme, calamint, and beach wormwood for sunny areas.
    l. Herbs of conspicuous foliage (see Table G).
    m. Herbs of continuous bloom (see Table H).
    n. Herbs of culinary usage, such as dill, borage, coriander, anise, sweet basil, sweet marjoram, chervil, summer savory, spearmint, orange mint, apple mint, and white peppermint.

Table A

Herbs for Low Edging

- Basil, Dwarf green
- Basil, Dwarf purple
- Bugleweed, Carpet
- Calamint
- Chives
- Germander
- Marjoram, sweet
- Nasturtium
- Nettle, Dead
- Parsley
- Pennyroyal
- Primrose
- Savory, Winter
- Thrift
- Thyme, Garden
- Thyme, Zygis
- Woodruff, Sweet
- Wormwood, Beach

Table B

Herbs for Ground Cover

Calamint — sun or partial shade
Carpet Bugleweed — sun or partial shade
Chamomile, Roman (English) — sun
Coltsfoot - in waste places — sun
Ivy, Ground - in waste places — sun or partial shade
Johnny Jump-up — partial shade
Lily-of-the-Valley — shade
Myrtle, Running — shade
Nettle, Dead — sun
Speedwell — shade
Thyme, Caraway — sun
Thyme, Lemon — sun
Thyme, Wild — sun
Violet, Common — partial shade
Wintergreen — shade
Woodruff, Sweet — partial shade
Wormwood, Beach — sun

Table C

Herbs for Crevices

- Chamomile, Roman (English)
- Thrift
- Thymes
- Woodruff, Sweet

Table D

Herbs for Hedges and High Edging

- Basil, Sweet
- Basil, Sweet (Purple variety)
- Feverfew
- Germander
- Hyssop
- Lavender, True
- Rosemary
- Rue
- Sage, Garden
- Santolina
- Southernwood
- Wormwood, Roman

Rosemary is tender. Hyssop, rosemary, rue and southernwood may all be clipped like a box hedge. Hyssop and rue will not flower if tops are cut off, but either makes a beautiful flowering hedge, if not trimmed except at sides. All plants mentioned in the table are hardy perennials except the basils.

Table E

Tall Herbs for Garden High Spots

- Aconite
- Angelica
- Bay, Sweet
- Castor Oil Plant
- Dog Rose
- Elecampane
- Fennel, Sweet
- Fennel, Wild
- Hollyhock
- Liatris
- Loosestrife
- Lovage
- Marshmellow
- Mugwort, Common
- Mugwort, White
- Mullein, Great
- Myrtle, Erect
- Pokeweed
- Sage, Clary
- Sage, Pineapple
- Senna, Wild
- Snakeroot
- Sunflower
- Tansy, Common
- Tansy, Fern leafed
- Teasel
- Valerian
- Wormwood, Sweet

Angelica, elecampane, lovage, and common mugwort under favorable conditions grow to 7 or 8 feet tall. Hollyhock and sunflower grow to 10 or 15 feet high. Wild senna will make a 6-foot-high spreading bush each year. Great mullein will have a single stalk from 8 to 10 feet high. The remainder will be from 3 to 4 feet high, though erect myrtle will not reach the height for several years.

Table F
Herbs with Colorful Flowers

Red — Bergamot, Cardinal Flower, Hollyhock, Scarlet Pimpernel

Purplish Rose — Germander, Joe-Pye Weed, Pyrethrum, Apothecaries' Rose, Yarrow

Light Purplish Rose — Daphne, Wild Geranium, Valerian

Pink — Alum-Root, Dames Rocket, Dittany of Crete, Hollyhock, Hyssop, *Origanum Pulchellum*, Clove Pink, Damask Rose, Dog Rose, Kazanlik Rose

Orange — Butterfly Weed, Calendula, Coltsfoot, Elecampane, Golden Rod, Nasturtium, St. John's Wort, Common Tansy, Fern-leafed Tansy

Yellow — Nasturtium, Primrose, Rue; Brownish Yellow: Yellow flag, Wild Senna; Bright Yellow: Arnica, Yellow Bedstraw. Wild Indigo, Evening Primrose

Light Blue — Rosemary, Speedwell; Grayish blue: Sea Holly; Clear Vivid Blue: Chicory, Cornflower, Fennel Flower, Hound's tongue, Meadow Sage; Opens Rose, Turns to Blue: Borage, Italian Bugloss, Lungwort; Deep Blue: Aconite, Blue Flag, Hyssop, False Indigo, Spiderwort; Dark Purplish Blue: Larkspur, Stoechas Lavender, Violets; Light Purplish Blue: Spike Lavender, True Lavender

Rosy Lavender — Chives; Heliotrope: Heliotrope; Purple: Coneflower, Pasque Flower, *Salvia Horminum*; Magenta: Foxglove

White — White Bedstraw, Boneset, Dames Rocket, Feverfew, Fraxinella, Lily-of-the-Valley, White Mugwort, Pyrethrum; Creamy White: Dropwort; Bluish White: White Flag

Table G
Herbs of Conspicuous Foliage

Alum-Root
Angelica
Balm, Lemon
Baneberry
Basil, Dwarf (Green and Purple)
Basil, Sweet (Green and Purple)
Bedstraw, White
Bedstraw, Yellow
Bergamot
Blessed Thistle
Borage
Bugleweed, Carpet
Bugloss, Italian
Burnet
Cardoon
Castor Oil Plant
Celandine
Chamomile (German and Roman)
Chervil
Cicely, Sweet
Coltsfoot
Comfrey
Costmary
Dill
Dittany of Crete
Dropwort
Elder, English
Elecampane
Fennel (Wild and Sweet)
Feverfew
Fraxinella
Fumitory
Germander
Glasswort
Horehound
Indigo (False and Wild)
Jerusalem Oak
Lady's Mantle
Lavenders
Lovage
Lungwort
Madder
Marshmellow
Mints:
  Apple Mint
  American Apple Mint
  Orange Mint
  Black Peppermint
Mugwort, Western
Mullein, Great
Orach (Green and Purple)
Origanum pulchellum
Pasque Flower
Perilla
Pokeweed
Primrose
Queen of the Meadow
Rose Geranium
Rosemary
Rue
Sage, Clary
Sage, Pineapple
Samphire
Santolina, Gray
Sea Holly
Senecio
Senna, Wild
Snakeroot
Southernwood
Tansy, Common
Tansy, Fern-leafed
Thyme, Azores
Thyme, Lemon
Woodruff, Sweet
Wormwood:
  Sweet
  Beach
  Fringed
  Roman
  Silky

Table H
Continuous Bloom in Herb Garden

Early to Late Spring — Celandine, Coltsfoot, Lily-of-the-Valley, Pasque Flower, Primrose, Violets

Late Spring to Early Summer — Alum-Root, Carpet Bugleweed, Italian Bugloss, Sweet Cicely, Dames Rocket, Daphne, Dropwort, Flags, Fraxinella, Lady's Mantle, Lungwort, Running Myrtle, Pyrethrum, Queen of the Meadow, Rosemary, Sweet Woodruff

Early Summer to Mid-Summer — Arnica, Bedstraws, Borage, Chamomiles, Cornflower, Dittany of Crete, Feverfew, Foxglove, Fumitory, Wild Geranium, Germander, Heliotrope, Hollyhock, Hounds Tongue, Indigo (False and Wild), Larkspur, Lavenders, Marjorams, Nasturtium, Orach, Clove Pink, Evening Primrose, Roses, Rue, Clary Sage, *Salvia Horminum*, Gray Santolina, Sea Holly, Sneezewort, Speedwell, Valerian, Yarrow

Mid-Summer to Autumn — Aconite, Bergamot, Boneset, Butterfly Weed, Calendula, Chicory, Coneflower, Autumn Crocus, Elecampane, Fennel Flower, Golden Rod, Hyssop, Joe-Pye Weed, Liatris, Loosestrife, Scarlet Pimpernel, Pokeweed, Saffron, Pineapple Sage, St. John's Wort, Wild Senna, Common Tansy, Fern-leafed Tansy.

NOTE: Some plants can be kept blooming all season by cutting off old flowers; others will bloom a second time, if cut back after the first bloom.

Table I
Herbs That are Almost Evergreen

Bugleweed, Carpet
Burnet
Calamint
Chamomiles
(Self-sown fall plants)
Ground Ivy
Horehound
Hyssop
Nettle, Dead
Rue
Sage
Santolina, Gray
Savory, Winter
Southernwood
Thyme, Caraway
Thyme, Garden
Thyme, Wild

Table J
Herbs for a Bee Garden

Balm, Lemon
Basils
Bergamot, Red
Borage
Bugloss, Italian
Butterfly Weed
Catnip
Chamomile
Chicory
Cicely, Sweet
Daphne
Dropwort
Fennel
Foxglove
Germander
Ground Ivy
Hyssop
Lavenders
Marjorams
Melilot
Nettle, Dead
Queen of the Meadow
Rosemary
Sage
Savory, Winter
Teasel
Thymes

INFORMATION SHEET #8

Propagating Herbs

Herbs are propagated in the following ways:

1. Layering — The herbs most often layered are sage, thyme, winter savory, perennial marjoram, and lemon balm. Bend a branch to the ground. Secure a portion of it to the ground with a hairpin or wire. Cover a portion (at least one node) with an inch or two of soil and keep moist. Roots will form in about 4 weeks, and at this time you can detach the bent branch from the mother plant. This method ensures an exact duplication of the mother plant.
2. Cuttings — The herbs most often propagated by cuttings are mint (easiest), lavender, lemon balm, winter savory, pineapple sage, and rosemary. Take cuttings in the summer after the new growth has had time to harden. Make them 3 to 4 inches in length and take off the lower leaves and place in moist soil or in a glass of water. You may want to use some rooting hormone for easier rooting. Process takes from 5 or 6 weeks to several months depending on the material being rooted. This method also ensures exact duplication of the mother plant.
3. Root Division — The herbs most often propagated in this manner are marjoram, betony, lemon balm, winter savory, and thyme. This is done in the early spring. You should dig up the entire plant and separate the roots by hand or by cutting the roots apart. This method also ensures exact duplication of the mother plant.
4. Seed — Let the plants go to seed and just before they are ready to be blown by the wind, shake the plant or run your hand over the pod to release the seeds. You can leave the seeds on the ground to grow next year or collect them and plant them later. This is not an exact duplication of the mother plant. You can plant seeds indoors. Just fill containers to within one-half inch of the top. Sow seeds, cover lightly with soil, water, and cover with glass or plastic. Do not let soil dry out. After true leaves appear, transplant the seedlings to a garden or to flats.

INFORMATION SHEET #9

Herb Dyes

When dying with herbs use a fixative or mordant copperas (Ferrous Sulphate) or alum with cream of tartar.

This holds the colors and/or brings out the colors. Wool is the easiest fabric to dye. Cottons and linens must be boiled in an astringent solution first.

Immerse the material completely in boiling water and simmer for 2 to 3 hours. For wool, boil in mordant and then the dye bath or add mordant after the material has been saturated with dye. Using various mordants with madder will produce several different colors.

RED:

Garden Sorrel roots
Lady's Bedstraw young roots, formerly much used in the Hebrides to dye wool; deep red when stannous chloride is added and terra cotta when boiled for some time
Madder root
Pokeweed flower (crimson)

BLUE:

Elderberries
Chicory leaves
Elecampane root, mixed with ashes and whortleberries
Yellow flag flowers
Indigo plant

YELLOW:

Agrimony whole herb, gathered in September, pale brownish yellow; if gathered later, dyes wool a deep yellow
Lady's Bedstraw stem and leaves
Dyer's Broom (Dyer's Greenwood) gathered in June and July, for wool with alum and cream of tartar, bright yellow; called greening weed because it is used to turn blue wool green
Fumitory flowers for wool
Yarrow flowers, with alum
Toadflax flowers
St. John's wort flowers, with alum
Calendula flowers, boiled
Cardoon bottoms
Daphne seed, for woolens
Goldenrod flowers with alum, lemon yellow; bright yellow when stannous chloride added

BROWN:

Hops stalks, brownish red
Teasel flowers
Wild marjoram flowering tops for linen, brownish red
Goldenrod with copperas

GREEN:

Elder leaves, with alum
Hyssop leaves, greenish gray with copperas
Tansy young shoots, greenish gray with alum
Scotch broom plant
Dyer's broom combined with woad, alum, cream of tartar, sulphate of lime
Lily-of-the-Valley leaves
Parsley leaves
Yarrow leaves

PURPLE:

Pokewood berries, reddish purple, magenta
Elderberries with alum, violet; with alum and salt, lilac
St John's wort flowers with tannic acid, pinkish purple
Wild marjoram flowering tops, wool

BLACK:

Yellow flag roots with sulphate of iron
Elder root and bark of older branches

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INFORMATION SHEET #10

Herb Products

1. Fresh Seeds
    a. in a small envelope
    b. picture of herb on envelope
    c. on a card

2. Fresh Herbs
    a. potted plants
    b. wreaths or bouquets
    c. tissue - nosegay
    d. place cards and favors

3. Household Items
    a. aromatic bath
    b. fragrant rubbing lotions
    c. skin tonics and fresheners
    d. herb teas
    e. perfumed ink
    f. hair rinses
    g. catnip pads and mice
    h. herbal incense
    i. moth preservatives

4. Culinary Products
    a. seasonings
    b. herb bouquet
    c. savory seeds
    d. vinegars and pickles

5. Sweet Bags and Fragrances
    a. herb pillows
    b. sweet bags and sachets
    c. padded coat hangers
    d. fragrant foundation for bureau drawers
    e. Christmas cards
    f. fragrant confetti
    g. lavender fans
    h. lavender bottles

INFORMATION SHEET #11

Herbs Used in Commerce and Industry

Angelica
Anise
Balm, Lemon
Bedstraw, Yellow
Bene (Sesame)
Bergamot
Blessed Thistle
Bugloss, Dyer's
Calendula
Caraway
Cardoon
Chamomile
Chicory
Cicely, Sweet
Coriander
Cornflower
Dill
Elecampane
Fennel (Wild and Sweet)
Fenugreek
Flax
Flag, Sweet and White
Hollyhock
Hyssop
Indigo, Wild
Lavenders
Lovage
Madder
Marjoram, Sweet
Meadowsweet (Dropwort)
Mints:
    Orange Mint
    Peppermint
    Spearmint
Mustard, Black and White
Parsley
Perilla
Pyrethrum
Rose, Cabbage
Rose, Kazanlik
Rose, Geranium
Rosemary
Rue
Safflower
Saffron
Sage, Clary
Sage, Garden
Santolina, Gray
Tansy, Common
Tansy, Fern-leafed
Tarragon, French
Thyme, Garden
Valerian
Verbena, Lemon
Woad
Woodruff, Sweet
Wormwood (Common, Roman, Silky, Sweet)

INFORMATION SHEET #12

Herbs Useful in Flower Arrangements

Aconite
Agrimony
Alum-Root
Arnica
Bedstraw, White
Bedstraw, Yellow
Bergamot
Boneset
Bugloss, Italian
Butterfly Weed
Calendula
Cardinal Flower
Coneflower
Cornflower
Dill
Dropwort
Fennel
Fennel Flower
Feverfew
Flag, Blue
Flag, Yellow
Flag, White
Foxglove
Fraxinella
Geranium, Wild
Heliotrope
Hyssop
Jerusalem Oak
Joe-Pye Weed
Larkspur
Lavenders
Liatris
Lily-of-the-Valley
Loosestrife
Marjoram, Pot
Mugwort, White
Nasturtium
Orach, Red
Pasque Flower
Pelargonium, Rose
Perilla
Pimpernel, Scarlet
Primrose, Evening
Pyrethrum
Queen of the Meadow
Rocket, Dames
Sage, Clary
Sage, Meadow
Salvia Horminum
Sea Holly
Sea Lavender
Senecio
Speedwell
Tansy, Fern-leafed
Teasel
Thrift
Turtle-Head
Woad (flowers and seeds)
Woodruff, Sweet
Wormwood, Sweet
Yarrow, Common

INFORMATION SHEET #13

Why a Need for New Crops?

1. Potential Contribution to Economic Development

We are all better off as a result of new products. As diets become more sophisticated, more resources are required. Perhaps the prime example of a coordinated effort in new-crop development that paid high dividends is the development of oilseed rape in Canada. Canada is now the world leader in export of oil from this crop.

2. Reduction in Cost of Surplus Production

New crops compete with established crops for land and thus may reduce the total production of established crops. Therefore, if some land could be shifted from the production of crops now in surplus to those being imported, the costs of surplus disposal could be reduced at the same time as the balance of trade could be improved.

3. Reduction in Vulnerability of American Agriculture

   a. Water Supplies

   The development of crop plants with low water requirements, tolerance to drought, or the capacity to complete their life cycles quickly when moisture is available has the potential for maintaining agriculture where water supplies are decreasing.

   b. Salinity

   Crops differ in their tolerance to salinity. A beginning already has been made in developing crop varieties that have increased tolerance to salinity, and more progress can be anticipated as new plant types are developed from more divergent genetic materials.

   c. Air Pollution

   A growing need exists to develop more tolerant crops and/or new crops for production in the most adversely affected areas.

   d. Soil Erosion

   Perennial new crops, including bamboo, jojoba, and sanseveria, are compatible with soil conservation objectives. The crop architecture, rooting habit, and residue remaining after harvest are some of the features to be considered in selecting new crops if they are to control soil erosion.

   e. Pests

   Diversification of crops provides some protection against pests. Pests of one crop often do not trouble another.

4. Reduction in the Economic Vulnerability of American Farmers

U.S. agriculture is dominated by a few crops that have an inelastic demand with respect to price. The introduction of new crops that do not compete with present crops for the same market or are selectively adapted to certain regions or conditions within regions could reduce the economic vulnerability of many farmers.

5. Provision of Strategic Reserve and Stabilized Supply of Critical Crops

   a. New Crops As a Strategic and Commercial Hedge

   Development of appropriate new crops could serve the strategic interests of the country by providing alternative sources for imported raw materials that are not now produced domestically.

   b. Benefits of a Stable Supply

   Successful commercial U.S. production of a new crop that would substitute for a previously imported crop would of course decrease the imports from the foreign sources.

6. Improvement in Balance of Payments

Agricultural exports give the United States substantial balance of payments help. During fiscal years 1960 through 1987, commercial exports of U.S. farm products brought $514 billion back to the United States. In fiscal 1987 alone, commercial farm exports totaled $27.9 billion. Exports under Government programs such as Public Law 480 (Food for Peace) totaled over $35 billion for the 28-year period; in 1987 alone, exports under these programs amounted to about $1.5 billion.

The aggregate net contribution of agricultural exports to the U.S. balance of payments for 1960 through 1987 was $225 billion. The contribution in 1987 alone was more than $7 billion. By providing substitutes for crops now imported as well as new products salable in foreign markets, new crops offer some potential for decreasing the current trade imbalance.

7. Improved Productivity

Needed, however, are crop choices that will permit better use of land that lies idle for portions of the year. With more crop choices it may be possible to increase the opportunities for double-cropping or finding substitutes for summer fallow.

8. Useful New Products

a. Medicinal Plants

About one-fourth of all prescriptions contain one or more biologically active substances derived from higher plants.

b. Pesticides

Certain plant-derived insecticides, including nicotine, rotenoids, pyrethrum, and hellebore, have been used for centuries, but many additional plant substances with a variety of biological activities against insects have been discovered in recent years.

c. Oils and Waxes

Little need exists for new sources of edible oils except possibly for replacing imports, such as coconut oil, and satisfying changing dietary desires for specific types of unsaturated or dietary oils. The market potential for new plant-derived oils and waxes for industrial and specialty uses is much greater.

d. Fiber

Fiber for preparing paper pulp is by far the largest market, and it has resisted the inroads of synthetic raw materials. The principal reasons for seeking new crops for pulp-making fiber are to find sources that are less costly and produce higher returns. In times of high per capita usage of paper and paperboard, tree farming and reforestation programs in some regions of the United States fall short of replacing the wood that goes into pulping operations.

9. Horticultural Crop Needs

The demand for new types of trees, shrubs, flowers, bedding plants, ground covers, lawn grasses, and vegetables suitable for growing in pots and other types of containers for servicing the needs and desires of more than 35 million homeowners is never ending.

10. New Food Demands

Indications of consumer preferences and behavior presumably would apply to foods derived from new crops as well as to existing foods.

11. Needs in Animal Feeding

For ruminants, two new-crop possibilities appear to have the greatest potential: (1) increasing the digestibility of the lignocellulose component of forages, and (2) developing unconventional high-yielding alternative sources of nutrients. These may include certain types of trees (alder, aspen, poplar) as well as some aquatic plants now regarded as weeds.

12. Honeybees

Bees are used by many growers to pollinate major crops of fruits, berries, vegetables, tree nuts, legumes, and oilseeds. About a third of all colonized bees are actually rented out for this purpose. The statistics in 1985 showed that $9.7 billion of increased crop yields and quality were a direct result of honeybee crop pollination. (Champaign - Urbana News Gazette "Honeybees work worth $9.7 billion" on Sunday March 5, 1989.)

INFORMATION SHEET #14

Selected New Crops

1. Soybean

Until two decades had elapsed in the 20th Century the soybean (*Glycine max (L.) Merrill*) was considered a minor crop and, to many, not a very promising candidate for permanent status in U.S. agriculture. Yet the first introduction of soybean had been made in 1765, before the founding of the United States as a separate nation. At first a curiosity and later a forage or cover crop, soybean became a major source of both oil and seed protein during World War II. It is now one of the three major U.S. crops. In 1980-1982, wheat and corn were first and second in area harvested, and soybean was third. In the same years, corn was first in value of production, and soybean was second.

Truly a success story, the soybean's history illustrates some important points:

a. Increasing need for margarine oil created a need for vegetable oil during the 1920s.

b. The one- and two-row combine became available in the 1930s, and this made soybean grain production practical.

c. Germplasm collections and their subsequent evaluations in the early years of the 20th century provided the research base for the development of improved varieties and the rapid rise to importance of those varieties in the third and fourth decades of the century.

d. Production research by different classes of specialists greatly increased the productivity of the crop.

e. First-rate utilization research provided for improved products from both the meal and the oil, thus expanding markets.

f. A true commodity champion, A.E. Staley made critical commitments to the crop in the form of investments in processing facilities.

Reference:

Caldwell, B.E., ed. 1973. *Soybeans: Improvement, Production and Uses.* Madison, Wisconsin: American Society of Agronomy.

2. Sunflower

Native to North America, the sunflower (*Helianthus annus L.*) was domesticated about 3,000 B.C. and was utilized for food over much of the present United States at the time the first European settlers arrived. Imported to Europe, probably in the 16th Century, it was first processed for oil, and by the end of the 19th century it had become an important oilseed crop in Russia.

Sunflower has become an important U.S. crop for domestic use and export, and it has created many new businesses and additional employment. Critical to this successful development were:

a. Continuing research on cultural practices, variety testing, weed control, and uses at a few state agricultural experiment stations in the 1950s and 1960s. This work encouraged the development of small companies that processed nonoilseed sunflower for birdfeed and human food.

b. Introduction of high-oil Russian varieties by the U.S. Department of Agriculture and testing of the seed by the Minnesota Agricultural Experiment Station.

c. Trading of corn and other crop germplasm to Russia for high-oil sunflower varieties by U.S. companies and use of these varieties until about 1973, when they were replaced by U.S. hybrids.

d. Construction of factories to extract oil from sunflower seed, beginning with one in Minnesota in 1967.

e. Strong industry support for a wide spectrum of research and developmental work on oilseed sunflower.

Nonoilseed sunflower exceeded oilseed sunflower in acreage until 1972, when 510,000 acres of oilseed and 209,000 acres of nonoilseed varieties were grown. Oilseed acreage subsequently increased to more than 5 million acres in 1979, while nonoilseed acreage increased to more than 300,000 acres in 1981.

Reference:

Carter, J.F., ed. 1989. *Sunflower Science and Technology.* Madison, Wisconsin: American Society of Agronomy.

3. Oilseed Rape and Mustard

Together, oilseed rape and mustard rank worldwide as the fourth or fifth most important source of vegetable oil, much of it used for edible purposes. In Canada, thanks to excellent coordinated research programs covering genetic improvement, production practices, utilization, and marketing, rape (*Brassica napus L.*) and turnip rape (*B. campestris L.*) together rank second to wheat in importance and are a major source of oil and protein in the nation's economy. Canada is now the world leader in export of oil derived from rape. In the United States, rape species are grown as oilseed crops on only a few acres. Very little scientific work is being devoted to their improvement. (In southeastern United States, however, turnip and mustard are grown widely for greens, and the technology and pest control techniques to produce the crops for this purpose have been developed.)

The success of the oilseed crops in Canada resulted in large measure from the following:

a. Adapted varieties of rape and turnip rape were developed, and the crop rose to major importance in western Canada in the 1950s and 1960s.

b. Through genetics and plant breeding the oil was improved in quality for food by eliminating erucic and eicosenoic acids. The meal was rendered safe and nutritious for livestock by major genetic reductions in levels of the toxic glucosinolates. The modified varieties are classed as a new crop called canola.

c. Strong industry and public support of research permitted long-term commitments of scientists of many disciplines to improvement of the crop.

Reference:

Harapiak, J.T., ed. 1975. *Oilseed and Pulse Crops in Western Canada.* Calgary, Alberta: Western Co-Operative Fertilizers Ltd.

4. Crambe

Crambe (*Crambe abyssinica H.*), a member of the mustard family, is an annual plant that grows wild in the Ethiopian highlands and North African plains. It produces an oil in which erucic acid is an important fatty acid component. The oil has many potential industrial uses, including: a lubricant in the continuous casting of steel and other metal-forming operations; a spinning lubricant in the textile industry; a source of derivatives that blend with natural and synthetic rubber to increase their elasticity; and, following hydrogenation, a glossy wax.

Derivatives of erucic acid have many commercial uses. Most oil with high levels of erucic acid has been obtained from rapeseed, but that supply now is less plentiful as a result of the development of erucic acid-free types.

Crambe is widely adapted. It can be grown as a spring crop in the Pacific Northwest and the Corn Belt or as winter crop in Texas.

The major problems in establishing crambe on a commercial basis are procurement of high quality seed; coordination of production, processing, and marketing; utilization of the meal, which has high levels of toxic glucosinolates; and, because of the small acreage in the pilot plantings, inability to obtain the information required to elicit the Environmental Protection Agency's approval to use the herbicides needed. The experience with crambe clearly illustrates how important it is to have all the components of development in the "go" condition.

Reference:

Twigg, J.W. 1981. Crambe, *Crambe abyssinica H.* In *Feasibility of Introducing New Crops: Production-Marketing-Consumption (PMC) Systems.* ed. E.C. Knox and A.A. Theisen, 150-173. A report prepared for the National Science Foundation. Emmaus, Pennsylvania: Rodale Pess.

5. Jojoba

Jojoba (*Simmondsia chinensis (Link) Schneider*) is a long-lived shrub with deep taproots that is native to desert areas of northwestern Mexico and southwestern United States. It grows where temperatures do not fall below 15°F, annual rainfall is 3 to 18 inches, and soils are well drained. It has high tolerance to salinity and alkalinity. Some 30,000 acres of jojoba are being grown in southern California, Arizona, and Texas.

The seed oil is a liquid wax similar to sperm whale oil. Most of the current supply of jojoba oil is being used in the cosmetics industry. With a larger supply and a lower price it could provide an ingredient of superior lubricating oils for automobile transmissions. It can be hydrogenated to form a soft cream useful in polishes or a hard wax useful in the production of candles.

One problem in commercial development is the long time (5 to 7 years) before a jojoba plant will bear enough seed to harvest. To provide for harvesting the seed mechanically, the plant must be trained or pruned to form a narrow hedge or group of branches at the base with the shrublike form about 4 feet above the ground.

References:

Hogan, L., and W.P. Bemis. 1983. Buffalo gourd and jojoba: Potential new crops for arid lands. *Advances in Agronomy* 36:317-349.

Yermanos, D.M. 1979. Jojoba — a crop whose time has come. *California Agriculture* 33(7,8):4-7,10,11.

6. Meadowfoam

Meadowfoam (*Limnanthes alba Benth.*) is the most promising of several species of Limnanthes that are native to northern California and Oregon. It is a low growing, herbaceous winter annual adapted to poorly drained soils. Interest in the domestication of meadowfoam followed studies at the U.S. Department of Agriculture's Northern Regional Research Center at Peoria, Illinois, which showed that more than 90 percent of the fatty acids in the oil are long-chain types with 20 to 22 carbon atoms in the molecular chains. By appropriate chemical treatments, ester compounds with 40 to 44 carbon atoms can be formed. These compounds have properties similar to those derived from jojoba.

Initial collections were made in 1962, and the more promising were grown at Corvallis, Oregon, in 1966. A variety called Foamore was developed from a single plant selection made in 1970. Further improvements are being made, particularly in resistance to shattering of seed.

Production practices from planting to combine harvest have been developed, and oil removal can be achieved by crushing or solvent procedures. The greatest needs are for further research and development, and obtaining federal approval for use of selective herbicides.

Reference:

Jolliff, G.D. 1981. Development and production of meadowfoam *(Limnanthes alba)*. In *New Sources of Fats and Oils*. ed. E.H. Pryde, L.H. Princen, and K.D. Mukherjee, 269-285. AOCS Monograph No. 9. Champaign, Illinois: American Oil Chemists Society.

7. Kenaf

Kenaf (*Hibiscus cannabinus L.*), a fast-growing tropical or semitropical annual plant, is a member of the same plant family as cotton and hibiscus. For many years the fiber in the bark has been extracted by retting, like that of jute, hemp, and flax, and it has been used in the manufacture of cordage. Major production for this purpose is in Thailand, India, and China. Removal of the fiber by retting is too labor-intensive to permit kenaf culture for cordage fiber in the United States.

Good quality chemical pulps and newsprint can be prepared from kenaf. The yields of fiber from kenaf at present are slightly less than those from pulpwood, but kenaf is said to require significantly less energy for pulping.

A number of individual companies and organizations, including the American Newspaper Publishers Association, the Technical Association of the Pulp and Paper Industry, and Kenaf International have actively sought information or made test runs with kenaf in the last two or three decades. Most of the overall coordination and catalysis, as well as the initial impetus, have come from the U.S. Department of Agriculture's Northern Regional Research Center at Peoria, Illinois. A number of daily newspapers in various sections of the country have had trial editions printed on kenaf paper. Kenaf International is currently active in promoting the crop. Though there is now no commercial acreage in the United States, seed increase is occurring, and several hundred acres have been planted each year for the past several years.

A kenaf fiber pulp mill, constructed in accordance with research information developed in the United States, started operating in Thailand in 1981. This mill uses about two-thirds of Thailand's kenaf production. The possible use of kenaf for pulping is under consideration in many countries.

Reference:

Taylor, C.S., and E.L. Whiteley. 1981. Kenaf, Hibiscus cannabinus L. In *Feasibility of Introducing New Crops: Production-Marketing-Consumption (PMC) Systems.* ed. E.C. Knox and A.A. Theisen, 22-72. A report prepared for the National Science Foundation. Emmaus, Pennsylvania: Rodale Press.

8. Guayale

Guayale (*Parthenium argentatum G.*) is a perennial shrub native to desert areas of north central Mexico and southwestern Texas. Rubber is produced in stem and root tissue as small globules within cells. The globules are removed by finely grinding the stems and roots to break the cells; the globules coalesce in a liquid medium. The quality of the rubber is essentially equivalent to that obtained from the rubber tree.

Because natural rubber is critical to U.S. security and to U.S. industry, and because of the large amounts imported, there has been interest in guayale's domestication and improvement through breeding. Research by the U.S. Department of Agriculture during World War II and more recent cooperative research by the U.S. Department of Agriculture and certain states show that the area of adaptation can be expanded, the yield increased, and the rubber content raised. Production practices are being improved.

More must be done on processing and marketing research and development, particularly with reference to disposal of by-products, principally waxes, resins, and bagasse. Because of the bulk of harvested plants and the need to process freshly harvested material, processing and production must be in close proximity. The price of imported natural rubber will have a powerful influence on guayale's future, particularly with respect to gaining interest and support from industries that use rubber.

Reference:

Ladig, G.L. 1981. Guayale, Parthenium argentatum G. In *Feasibility of Introducing New Crops: Production-Marketing-Consumption (PMC) Systems.* ed. E.C. Knox and A.A. Theisen, 100-120. A report prepared for the National Science Foundation. Emmaus, Pennsylvania: Rodale Press.

9. Cuphea

Species of cuphea produce oils differing greatly in fatty acid composition. This was discovered more than 20 years ago by U.S. Department of Agriculture scientists at the Northern Regional Research Center at Peoria, Illinois. Of particular interest are those species with high levels of medium-chain saturated fatty acids, including myristic, with a molecular chain 14 carbon atoms in length; lauric, with 12 carbons; capric, with 10 carbons; and caprylic, with 8.

At present, large amounts of coconut and palm kernel oils are imported into the United States and other industrialized countries to provide lauric acid for manufacture into soaps, detergents, lubricants, and other products. Derivatives of caprylic and capric acids have important applications in medical, nutritional, and dietetic fields. If cuphea could be domesticated to provide varieties with high seed yields, there would be tremendous commercial interest in it. Some species have been used as ornamentals.

Initial efforts to evaluate and domesticate cuphea began about 10 years ago at the University of Gottingen in West Germany. Currently agronomic and genetic research in the United States is underway by the U.S. Department of Agriculture at Phoenix, Arizona, and Beltsville, Maryland. At Corvallis, Oregon, a species evaluation and breeding program is supported jointly by Oregon State University, the U.S. Department of Agriculture, and companies interested in developing a source of medium-chain fatty acids in the United States. Germplasm collections and taxonomic studies have been made cooperatively by Kent State University in Ohio, the U.S. Department of Agriculture, and industry.

Obstacles to be overcome in adapting cuphea to commercial production include: premature shattering of seed; a long flowering and ripening period; seed dormancy, leading to poor germination; and sticky glandular hairs on the stems, leaves, and flowers, which complicate harvesting. Because of these obstacles and because of the high value of the oil, it is extremely important that the research on cuphea be continued over a period of at least 10 years.

References:

Miller, R.W., F.R. Earle, I.A. Wolff, and Q. Jones. 1964. Search for new industrial oils. IX. Cuphea, a versatile source of fatty acids. *Journal of the American Oil Chemists Society* 41:279-280.

Thompson, A.E. 1984. Cuphea — a potential new crop. *Hort-Science* 19:352-354.

10. Buffalo Gourd

Buffalo gourd *(Cucurbita foetidissima HBK)* is a perennial cucurbit indigenous to the arid and semiarid regions of western North America. The association between the aboriginal Americans and the buffalo gourd existed for as long as 9,000 years. Although it was never a cultivated plant, it was an excellent "camp follower."

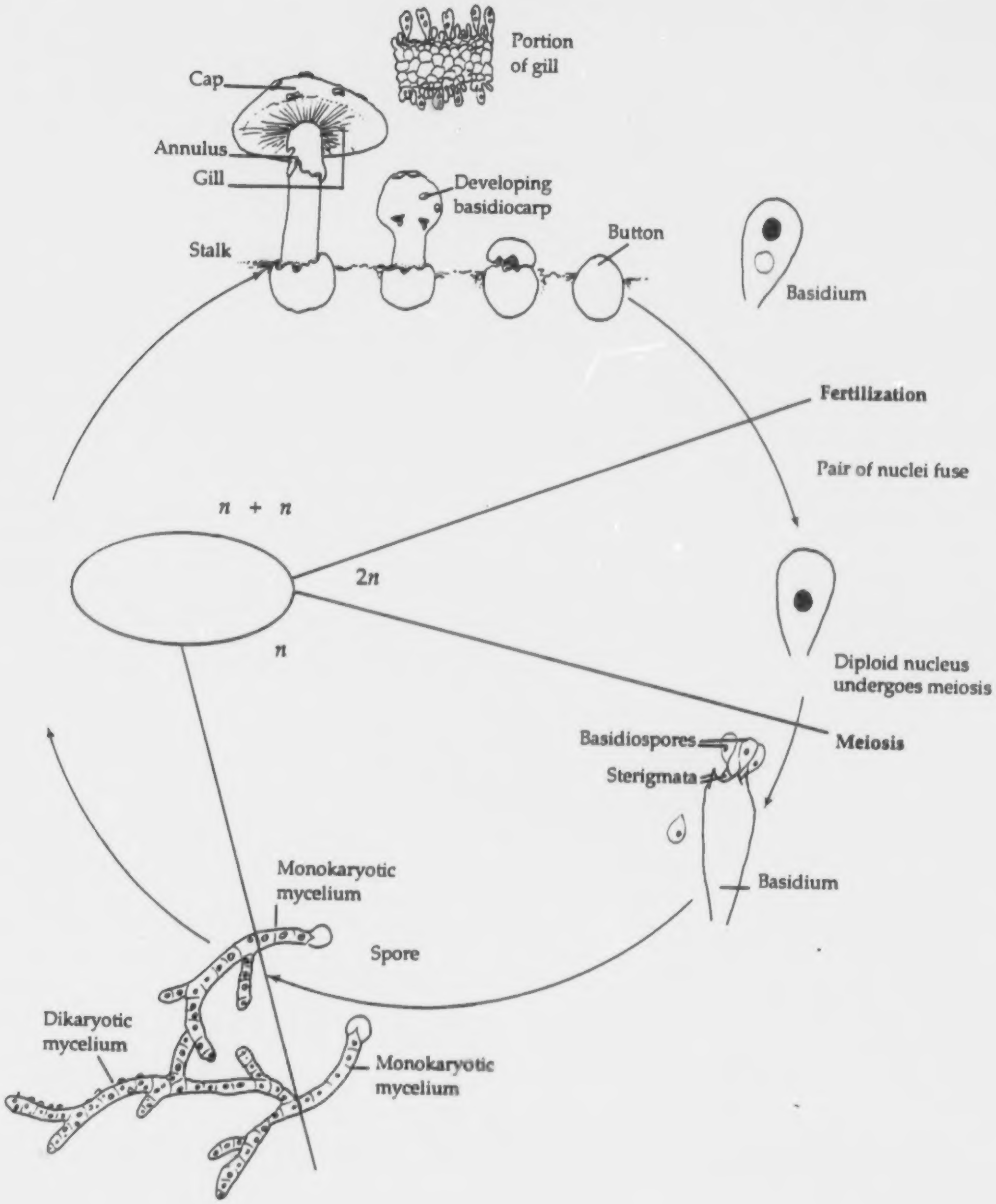
The fruit is usually round, with a diameter of 2 to 3 inches. The number of seeds per fruit ranges from 200 to 300, with an average weight of 4 grams (0.14 ounce) per 100 seeds. The seed contains 30 to 40% edible oil and 30 to 35% protein. Yields of seed may average 1800 pounds per acre. The large storage root contains about 18% starch on a fresh weight basis. Root yields of 18,000 pounds per acre appear reasonable.

Reference:

Hogan, L., and W.P. Bemis. 1983. Buffalo gourd and jojoba: Potential new crops for arid lands. *Advances in Agronomy* 36:317-349.

TRANSPARENCY MASTER #1

Parts of a Mushroom and the Life Cycle of a Mushroom


Portion of gill
Cap
Annulus
Gill
Developing basidiocarp
Button
Stalk
Basidium
Fertilization
Pair of nuclei fuse
n + n
2n
n
Diploid nucleus undergoes meiosis
Basidiospores
Meiosis
Sterigmata
Basidium
Monokaryotic mycelium
Spore
Dikaryotic mycelium
Monokaryotic mycelium

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TRANSPARENCY MASTER #2

Why a Need for New Crops?

1. Potential Contribution to Economic Development

2. Reduction in Cost of Surplus Production

3. Reduction in Vulnerability of American Agriculture
    a. Water Supplies
    b. Salinity
    c. Air Pollution
    d. Soil Erosion
    e. Pests

4. Reduction in the Economic Vulnerability of American Farmers

5. Provision of a Strategic Reserve and Stabilized Supply of Critical Crops
    a. New crops as a strategic and commercial hedge
    b. Benefit of a stable supply

Why a Need for New Crops (con't.)

6. Improvement in Balance of Payments

7. Improved Productivity

8. Useful New Products

    a. Medicinal Plants
    b. Pesticides
    c. Oils and Waxes
    d. Fiber

9. Horticultural Crop Needs

10. New Food Demands

11. Needs in Animal Feeding

12. Honeybees

TRANSPARENCY MASTER #3

Selected New Crops

A. Soybean

B. Sunflower

C. Oilseed Rape and Mustard

D. Crambe

E. Jojoba

F. Meadowfoam

G. Kenaf

H. Guayale

I. Cuphea

J. Buffalo Gourd

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STUDENT ACTIVITIES

Student Worksheet #1 — Drying and Storing Herbs

Student Worksheet #2 — Designing an Herb Garden

Student Worksheet #3 — Effect of Various Growing Media on Mushroom Growth

For additional activities, teachers may refer to the "Suggested Teaching Activities and Procedures" section in the Instructor's Guide.

STUDENT WORKSHEET #1

Drying and Storing Herbs

1. When harvesting perennial herbs the herb should be cut ________ of the way down the stalk.

2. Annuals should be harvested by leaving ____________ of stalk for a second season's growth.

3. Match the following statements on drying and storing herbs with the correct answers:

a. ____ Harvested when flowers are opened to the middle

b. ____ Can be frozen for future use

c. ____ Takes three to six weeks and should snap when bent

d. ____ Dipped in boiling, salted water until they just wilt

e. ____ Dry on baking sheet at 250° with the door open

f. ____ Seeds spread on screen covered with a cloth for 7 to 10 days

g. ____ Hang on a cord in a well-ventilated room

h. ____ Mixed with one quart of vinegar for 4 to 6 weeks

1. leaves
2. bundles
3. french tarragon
4. roots
5. chives
6. sesame
7. mints
8. lavender

4. It takes about ________ of fresh product to produce one (1) pound of dried product.

STUDENT WORKSHEET #1 — Key

Drying and Storing Herbs

1. When harvesting perennial herbs the herb should be cut *2/3* of the way down the stalk.
2. Annuals should be harvested by leaving *3 to 4 inches* of stalk for a second season's growth.
3. Match the following statements on drying and storing herbs with the correct answers:

   a. *8* Harvested when flowers are opened to the middle
   b. *5* Can be frozen for future use
   c. *4* Takes three to six weeks and should snap when bent
   d. *7* Dipped in boiling, salted water until they just wilt
   e. *1* Dry on baking sheet at 250° with the door open
   f. *6* Seeds spread on screen covered with a cloth for 7 to 10 days
   g. *2* Hang on a cord in a well-ventilated room
   h. *3* Mixed with one quart of vinegar for 4 to 6 weeks

   1. leaves
   2. bundles
   3. french tarragon
   4. roots
   5. chives
   6. sesame
   7. mints
   8. lavender

4. It takes about *8 lbs* of fresh product to produce one (1) pound of dried product.

STUDENT WORKSHEET #2

Designing an Herb Garden

Complete The Following Steps:

1. Select the sets for a garden (real or hypothetical but have a situation in mind).
2. Measure the area and draw it to scale on a sheet of paper. Make one copy for a draft.
3. Choose your desired herbs.
4. Place them on your first draft copy, drawing them at mature size. Take into consideration the colors, height and texture of the chosen herbs.
5. Now draw them on your good copy to be turned in. You should be able to defend your reason for placing your plants where you did.
6. Finally, make a list of plants based on your plan. This list should contain the name and quantity of each herb.

A Step Further:

1. Find out the prices of each herb and a total cost for your plan.
2. Compute the amount of yield to be gained from the herbs planted.
3. Going along with step 5 (above) have students make a list of possible uses for each herb planted.

STUDENT WORKSHEET #3

Effect of Various Growing Media on Mushroom Growth

Materials:

1. mushroom spores
2. growing containers
3. controlled area for growth
4. soil
5. prepared horse manure
6. fresh horse manure
7. compost

Setup:

1. Place media in separate containers with the prepared horse manure or purchased mushroom media as the control.
2. Spread spores evenly over containers.
3. Place in dark growing area at a beginning temperature of 19°C. After a month reduce the temperature to 13°C with humidity at 85%.
4. Take observations weekly for a month.

Questions:

1. Which media were able to produce mushrooms?
2. Why were mushrooms not able to grow in the remaining media?
3. What components are consistent in those media supporting mushrooms?
4. What do mushrooms feed on in the media?
5. What else can be done to the media to produce better mushrooms?
6. How long did it take for the fruiting bodies to appear?

UNIT D: Food Science and Technology

PROBLEM AREAS:

1. Processing Agricultural Products
2. Adhering to Government Regulations
3. Meeting Nutritional Needs of Food Consumers
4. Packaging and Distributing Food Products
5. Identifying Career Opportunities in Food Science

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Food Science and Technology

PROBLEM AREA: Processing Agricultural Products

RELATED PROBLEM AREAS:

1. Understanding Food Science Technology (Central Core Cluster)
2. Adhering to Government Regulations
3. Meeting Nutritional Needs of Consumers
4. Packaging and Distributing Food Products

PREREQUISITE PROBLEM AREA(S):

1. Understanding Food Science Technology (Central Core Cluster)

LEVEL: Preparatory

OCCUPATIONAL TASKS ADDRESSED: None

STATE GOALS FOR LEARNING:

In planning the instruction for this problem area, teachers can promote the development of several student learning objectives which are related to the State Goals for Learning in Biological and Physical Sciences. These objectives are listed on the Learning Assessment Plan forms included on the following pages(s). Those learning objectives marked with an asterisk (*) are taken from the sample lists provided by the Illinois State Board of Education.

CORE

Illinois Agricultural Core Curriculum

Agricultural Education 124 Mumford Hall 1301 W. Gregory Drive University of Illinois Urbana, IL 61801

Director: Dale A. Law, Ed.D.
Principal Investigator: Jerry D. Pepple, Ed.D.
Research Assistant: Randy J. Bernhardt

Illinois Agricultural Core Curriculum Rev.

Submission Date ______________
☐ Original submission ☐ Revision
Page ____ of ____

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☒ Sciences ☐ Physical Development/Health

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)
COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐
District Name
City

Contact Person: ______________
Title: ______________
Phone: (   )

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will have a working knowledge of the principles of scientific research and their application in simple research projects.

III. LEARNING OBJECTIVES	IV. ASSESSMENT A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	V. EXPECTATIONS Percent of Students Expected to Achieve Objective
By the end of grade (circle one) 3 6 8 [✓ 11] students should be able to:					
*1. Apply scientific knowledge, through the proper use of techniques, laboratory instruments, and the unbiased reporting of results.					
1281					1282

ISBE 41-78 (1/88)

Agricultural Business and Management
Food Science and Technology

Processing Agricultural Products

Submission Date ____________
☐ **Original submission** ☐ **Revision**
Page ____ of ____

I. LEARNING AREA *(check one)*
☐ Language Arts
☐ Mathematics
☒ Sciences
☐ Fine Arts
☐ Social Sciences
☐ Physical Development/Health

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)

COUNTY	DISTRICT	ESC

District Name

City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will have a working knowledge of the social and environmental implications and limitations of technological development.

Contact Person: ____________
Title: ____________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
1. Develop an understanding of the uses of microorganisms in food processing, such as fermentation.					
*2. Relate several ways viruses and bacteria are used in industry research.					

Processing Agricultural Products

Illinois Agricultural Core Curriculum Rev.

Agricultural Business and Management
Food Science and Technology

Illinois Agricultural Core Curriculum Rev.

Submission Date ____________________

☐ Original submission ☐ Revision

Page _____ of _____

I. LEARNING AREA *(check one)*

☐ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☒ Sciences ☐ Physical Development/Health

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)

COUNTY	DISTRICT	ESC

District Name

City

Contact Person: ____________________

Title: ____________________

Phone: ( )

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will have a working knowledge of the concepts and basic vocabulary of biological, physical, and environmental sciences and their application to life and work in contemporary technological society.

III. LEARNING OBJECTIVES

By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:

III. LEARNING OBJECTIVES	IV. ASSESSMENT A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	V. EXPECTATIONS Percent of Students Expected to Achieve Objective
1. Understand some principles of food preservation. 2. Develop an understanding of heat preservation and processing.					
3. Develop an understanding of cold preservation and processsing. 4. Develop an understanding of food dehydration and concentration.					
5. Develop an understanding of food irradiation and microwave heating.					
6. Develop an understanding of meat curing.					
7. Develop an understanding of how selected foods are preserved.					
*8. Understand the results of the effect of heat energy on samples of matter.					
*9. Recognize the results of the effect of heat energy on samples of matter.					
10. Conduct selected laboratories in food science.					

Processing Agricultural Products

Agricultural Business and Management
Food Science and Technology

ISBE 41-78

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Food Science and Technology

PROBLEM AREA: Processing Agricultural Products

STUDENT LEARNING OBJECTIVES

Upon completion of their study of this problem area, students will be able to:

1. Understand some principles of food preservation.
2. Develop an understanding of heat preservation and processing.
3. Develop an understanding of cold preservation and processing.
4. Develop an understanding of food dehydration and concentration.
5. Develop an understanding of food irradiation and microwave heating.
6. Develop an understanding of meat curing.
7. Develop an understanding of the uses of microorganisms in food processing, such as fermentation.
8. Develop an understanding of how selected foods are preserved.
9. Conduct selected laboratories in food science.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Food Science and Technology

PROBLEM AREA: Processing Agricultural Products

PROBLEMS AND QUESTIONS FOR STUDY	INSTRUCTOR'S NOTES AND REFERENCES
1. What is food processing and food preservation?	
2. What are some basic food preservation principles?	
3. How does heat treatment preserve a food product?	
4. What are some of the methods of preserving by heat?	
5. What is the principal reason for preserving foods by chilling or freezing?	
6. What are some of the methods of preserving by cold treatment?	
7. What is homogenization? Why is it done to milk?	
8. Why does food dehydration and concentration preserve foods?	
9. What is the process of food irradiation?	
10. Why is food irradiation done to foods?	
11. How does meat curing preserve food products?	
12. What are the processes of meat curing?	
13. How does fermentation preserve food products?	
14. Explain how fermentation is done.	
15. How are certain foods commonly preserved?	
16. Conduct food science laboratories.	

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Food Science and Technology

PROBLEM AREA: Processing Agricultural Products

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES

1. Define preservation.
2. Discuss basic principles of food preservation with the class.
3. Explain to the class different types of microorganisms and their environmental growth requirements.
4. Ask students, "What is a process that you are familiar with, that uses heat to preserve a food product?" Discuss the different types of heat preservation.
5. Have students complete Student Worksheet #1.
6. Discuss with students methods of heat preservation including those methods used both before and after packaging.
7. Ask students, "What causes food to be preserved when it is refrigerated or frozen?" Discuss the principles and methods of food refrigeration and food freezing.
8. Have students complete Student Worksheet #2.
9. Explain homogenization and separation of milk.
10. Take a class trip to a dairy processing business. Have an employee discuss the processes used and the dairy products that the business makes.
11. Have students conduct a food science laboratory on the effects of heat and pH on color and texture of green vegetables. Refer to Student Worksheet #3.
12. Discuss with students the process of food dehydration.
13. Have students complete Student Worksheet #4.
14. Discuss with students the application of microwaves and food irradiation to food processing and food preservation.
15. Ask students, "What is meat curing? What foods are cured?" Discuss meat curing, the ingredients used, and methods of meat curing. Discuss the controversy over nitrites and nitrates.
16. Conduct student laboratory experiments on meat curing. Refer to Student Worksheets #5 - #7.
17. Take students on a field trip to a meat processing plant. Have an employee show and discuss meat curing.
18. Ask students, "What is fermentation? What products are preserved through fermentation?" Discuss the process of fermentation, and what types of food are processed or preserved through fermentation.
19. Ask students to list different ways certain foods are processed. List these on the board. Refer to Information Sheet #11.
20. Conduct laboratory experiments in food science. Refer to Student Worksheets #8 - #9.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Food Science and Technology

PROBLEM AREA: Processing Agricultural Products

REFERENCES

1. *The Science Workbook of Student Research Projects in Food-Agriculture-Natural Resources.* (1985). College of Agriculture, The Ohio State University, 2120 Fyffe Road, Columbus, OH 43210. (614) 422-1734.

2. *The Meat We Eat.* (1985). Romans, Jones, Costello, Carlson, Ziegler. Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050.

*3. *Introduction to Food Processing.* (1985). Jelen, Pavel. Reston Publishing Company, Inc., A Prentice-Hall Company, Reston, VA 22090.

*4. *Food Science.* (1986). Potter, Norman N. 4th edition. The AVI Publishing Company, Inc., c/o Van Nostrand Reinhold, 115 Fifth Ave., New York, NY 10003.

*5. *Experiments in Food Science.* The Institute of Food Technologists, 221 N. LaSalle Street, Chicago, IL 60601. (312) 782-8424.

*Indicates highly recommended reference

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTIONAL RESOURCES

These resources are intended for use by teachers in planning and teaching the materials for this problem area and may be adapted to fit the teaching method(s) used.

INFORMATION SHEET #1 — Basic Principles of Food Preservation

INFORMATION SHEET #2 — Degrees of Preservation by Heat

INFORMATION SHEET #3 — Heating Before or After Packaging

INFORMATION SHEET #4 — Food Freezing

INFORMATION SHEET #5 — Separation and/or Homogenization of Milk

INFORMATION SHEET #6 — Food Dehydration

INFORMATION SHEET #7 — Food Irradiation and Microwave Heating

INFORMATION SHEET #8 — Meat Curing

INFORMATION SHEET #9 — Methods of Meat Curing

INFORMATION SHEET #10 — Nitrates and Nitrites Controversy

INFORMATION SHEET #11 — Fermentation Defined

INFORMATION SHEET #12 — How Certain Foods are Commonly Preserved

TRANSPARENCY MASTER #1 — Preservation Defined

TRANSPARENCY MASTER #2 — Basic Principles of Food Preservation

TRANSPARENCY MASTER #3 — Effect of Environmental Factors on Growth of Microorganisms

TRANSPARENCY MASTER #4 — Degrees of Preservation by Heat

TRANSPARENCY MASTER #5 — Heating Before or After Packaging

TRANSPARENCY MASTER #6 — Technological Principles of Heat Sterilization and Canning of Food

TRANSPARENCY MASTER #7 — The Standard 3-Piece Can

TRANSPARENCY MASTER #8 — Freezing Operation Principles

TRANSPARENCY MASTER #9 — Drying Operation Principles

TRANSPARENCY MASTER #10 — Food Sterilization by Irradiation

TRANSPARENCY MASTER #11 — Microwave Applications for Food Processing

TRANSPARENCY MASTER #12 — Meat Curing

TRANSPARENCY MASTER #13 — Some Industrial Fermentations in Food Industry

TRANSPARENCY MASTER #14 — Schematic Illustration of the Brewing Process

INFORMATION SHEET #1

Basic Principles of Food Preservation

1. For short-term preservation, there are two simple rules to follow.

   a. Keep food alive as long as possible. This is practiced with fish, seafood, poultry, fruits, and vegetables if possible. The possibilities are limited.

   b. If the food must be killed, clean it, cover it, and cool it as quickly as possible. This only delays deterioration for a short period of time (for hours or at most a couple days).

2. For long-term preservation, the inactivation of controlling microorganisms and enzymes, the principal causes of food spoilage, is required. Methods of accomplishing this inactivation are listed below.

   a. Heat — Most bacteria, molds, and yeasts grow best at temperature ranges of 16° - 38°C. Thermophiles grow at the range of 66° - 82°C. Most bacteria are destroyed in the range of 82° - 93°C, but bacterial spores are sometimes not destroyed by boiling water at 100°C for 30 minutes. For sterility, or total destruction of microorganisms, a temperature of 121°C (wet heat) must be maintained for 15 minutes or longer.

   b. Cold — Psychrotrophs will grow down to a temperature of 0°C, the freezing point of water and below. At a temperature of below 10°C, growth is slowed and becomes slower the lower the temperature is. When water in foods is completely frozen, there is no multiplication of microorganisms.

   c. Drying — Microorganisms need water for growth and survival. They get this water from the food in which they grow. Partial or complete drying is done to preserve the food against microbial spoilage.

   d. Acid — In sufficient strength acid changes bacterial proteins as it denatures food proteins; thus microorganisms are sensitive to acid. Acid combined with heat makes the heat more destructive to microorganisms.

   e. Sugar and salt — Fruits are preserved in sugar syrup and certain meats are preserved by placing them in a salt brine. When bacteria, yeasts, or molds are placed in a heavy sugar syrup or salt brine, water in the cells moves out through cell membranes and into the concentrated syrup or brine (this is called osmosis). This causes partial dehydration of the bacteria, yeasts, or molds.

   f. Smoke — Smoke contains preservative chemicals such as small amounts of formaldehyde and other by-products of burning wood. Smoke is also associated with heat which helps to kill microorganisms. The heat also dries out the food which contributes to preservation.

   g. Air — Creating a partial or total vacuum prevents aerobic microorganisms, which need oxygen to survive, from growing.

   h. Chemicals — Chemicals used to inactivate microorganisms in food include sodium benzoate, sorbic acid, sodium propionate, calcium propionate, ethyl formate, and sulfur dioxide.

   i. Radiation — Microorganisms are inactivated to varying degrees by different types of radiation; this process is also called "cold sterilization."

INFORMATION SHEET #2

Degrees of Preservation by Heat

1. Sterilization — refers to complete destruction of microorganisms. Because certain bacterial spores are heat resistant, this process requires a temperature of at least 121°C of wet heat for 15 minutes.

2. Commercially sterile — sometimes means the degree of sterilization at which all pathogenic and toxin-forming organisms have been destroyed, as well as all other types of organisms which if present could grow in the product and produce spoilage. Commercially sterilized foods may contain small numbers of resistant bacterial spores, but these normally will not multiply.

3. Pasteurization — involves a lower heat treatment, generally at temperatures below the boiling point of water. Two different primary objectives of pasteurization are:

   a. To destroy pathogenic organisms that may be associated with the food and could have public health significance; this objective applies to preservation of milk and liquid eggs.

   b. To extend product shelf life from a microbial and enzymatic point of view.

4. Blanching — generally applied to fruits and vegetables to inactivate natural food enzymes; also will destroy some microorganisms.

INFORMATION SHEET #3

Heating Before or After Packaging

1. Heating Food in Containers — Heating within the package requires less technical sophistication and produces quite acceptable quality with the majority of foods; most canned foods are heated within the package.

   a. Still retort — In this method of sterilization, one of the simplest, the cans remain still while being heated. Temperatures above 121°C generally cannot be used. The heating time to bring the cold spot (product in the center of the container) to sterilizing temperature is relatively long.

   b. Agitating retorts — Processing time is reduced substantially by shaking the cans during heating, especially if the foods are liquid or semiliquid. Faster heating allows temperatures above 121°C.

   c. Direct flame sterilization — In this method of sterlization, introduced to the U.S. from France, cans are directly contacted by flames. The cans are rotated as they are being conveyed past gas flames.

   d. In-package pasteurization — In-package heating need not be to the point of sterilization. Hot water sprays or steam jets are directed at the containers and varying temperature zones progressing to cooling temperatures are commonly used.

2. Heating Food Before Packaging — These methods are inherently less damaging to food quality, especially when the food can be readily subdivided (as with liquids) for rapid heat exchange. Also, heat doesn't have to penetrate through a container.

   a. Batch pasteurization — Liquid is heated in a large vat with mild agitation. For example, raw milk is brought to a temperature of 62.8°C for 30 minutes.

   b. High temperature-short time pasteurization (HTST) — This method is similar in process to batch pasteurization and produces a final product equivalent in bacterial destruction; it differs, however, in its time extent and temperature level. For example, raw milk is brought to a temperature of 71.7°C for at least 15 seconds. This method, widely used in the food industry, is not limited to preserving milk.

   c. Aseptic canning — Food is sterilized or commercially sterilized outside of the can and then aseptically placed in previously sterilized containers which are sealed in an aseptic environment. Ultra High Temperature (UHT) can be employed with aseptic canning. UHT is quick heating of liquid foods at extremely high temperatures. For example, 150°C for 2 - 4 seconds. Food has to be quickly cooled to prevent unfavorable product changes in quality.

   d. Hot pack or hot fill — This method involves packing previously sterilized or pasteurized foods, while hot, into clean but not necessarily sterile containers, under clean but not necessarily aseptic conditions.

3. Three-piece tin can — Because of the shape of the can, much of the food in the can will be overheated in order to heat the "cold spot" of the can to the proper temperature for sterilization. This usually causes the product to: (1) turn brown in color, (2) have a slightly "cooked" flavor, and (3) have little or no nutrient value because of nutrient destruction during the heating process.

INFORMATION SHEET #4

Food Freezing

The preservation aspect of food freezing is, in principle, the same as in drying: liquid water is made unavailable for growth of microorganisms, by immobilization as ice. The low temperature due to freezing is also an effective deterrent of microbial growth.

The main difference between refrigerated and frozen food is the physical state of the food. In frozen food, most of the water contained in it has turned to ice crystals. Refrigerated foods still have water in its liquid state and thus psychrophilic organisms can grow.

The main damage of freezing on food quality is texture change. This is because when water freezes, it expands by 9 percent in volume. The size of ice crystals may have a large effect on textural changes. In general, the faster the freezing, the smaller the ice crystals and the less the structural damage.

INFORMATION SHEET #5

Separation and/or Homogenization of Milk

Both of these processes are concerned with milk fat. When a fat-reduced product such as skim milk — or partially skimmed milk, usually containing 2 percent fat — is desired, the excess fat is removed from the normal milk by centrifugal separation.

Since fat is lighter than the aqueous phase, these large droplets will migrate slowly to the top if the milk is left undisturbed, eventually (in several hours) forming a thick layer of cream. In a centrifugal dairy separator, this creaming process is accomplished in a matter of seconds.

In order to avoid undesirable creaming in fluid milk products containing fat, the milk is homogenized by pumping through a special valve under high pressure. This mechanical treatment breaks the large fat globules into a multitude of very small ones one-fourth their original size, which is small enough to prevent undesirable creaming.

In partially skimmed milk and other products with defined fat content, the formation of the final desired fat content is accomplished by mixing appropriate amounts of homogenized and skimmed milk either in a special mixing tank after complete separation, or in a special centrifuge during the separation process.

Excess milk fat obtained by separation will be used for coffee cream, whipping cream, and other dairy cream products.

INFORMATION SHEET #6

Food Dehydration

The effectiveness of drying as a preservation technique is due to the removal of water, present in all perishable foods and required by all microorganisms for their growth. Since water is readily available for most consumers, dried foods may be constituted to their original composition quite easily at the point of final use. Water removal from dried foods is advantageous for the substantial reduction of their volume and weight since water is often the major food component. This is important for the economics of transportation and prolonged storage. Drying is not overly damaging to microorganisms. After reconstitution dried foods will be as perishable as the fresh product.

Food concentration through dehydration has a preservative effect. Sugar and salt, dissolved in water or other concentrated solutions have high osmotic pressures. When these are sufficient enough to draw water from microbial cells, or to prevent normal diffusion of water into these cells, a preservative condition exists. Heavy syrups and similar products will keep indefinitely without refrigeration even if exposed to microbial contamination, provided they are not diluted above a critical concentration by moisture pickup.

INFORMATION SHEET #7

Food Irradiation and Microwave Heating

The principle of irradiation is similar to that of canning: radioactive elements can be used to kill microorganisms present in food.

The irradiation can be applied in low doses for selective inactivation of the more sensitive pathogenic or spoilage organisms only. The possible industrial uses of high doses of irradiation for complete sterilization of foods may be more limited since different food materials respond differently to high doses of treatment.

The principal undesirable effects of irradiation sterilizing in some foods are flavor change, color change, and/or texture defects.

Food irradiation is the only new food preservation process in the 20th century.

Twenty years of intensive investigation on food irradiation has revealed the following information:[1]

Irradiated foods, on the whole, were as nutritious as their heat-processed counterparts. Irradiation did destroy various amounts of various nutrients, but the losses generally were of the same degree as from heat processing.

Significant levels of toxic or carcinogenic substances were not produced in foods when they were irradiated with approved dosages from approved radiation sources. Substantial margins of safety had been built into the upped levels of doses approved.

At approved doses, sterilized or pasteurized foods were safe from a microbiological standpoint.

Irradiation with approved dosages from approved sources did not contribute harmful levels of radioactivity to foods. Substantial margins of safety had been built into approved processes. All foods, water, and the air we breathe contain low levels of radioactivity, as does the human body. These levels, contributed to by radiations from the sun, are part of our natural environment. Sometimes they are increased by poorly controlled or ill-used man-made atomic power. But the natural low levels of food radioactivity were not raised to anywhere near harmful levels with approved radiation treatments.

Microwave Heating

Conventional heating employs a direct flame, heated air, direct contact with a hot plate, etc. The heat source causes food molecules to react largely from the surface inward, so that successive layers heat in turn.

In contrast, microwaves penetrate food pieces up to several centimeters of thickness uniformly, setting all water molecules and other polar molecules in motion at the same time. Heat is not passed by conduction from the surface inward, but instead it is generated quickly and quite uniformly throughout the mass. The result is an internal boiling of moisture. As a result there is virtually no surface browning or crusting from excessive surface heat.

Low thermal gradient microwave heating lends itself to numerous special applications. (Refer to Transparency Master #11.)

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[1] This information on irradiation reproduced from *Food Science*, 4th Ed. (1986). Potter, Norman N. p. 318. Permission granted by Van Nostrand Reinhold, New York

INFORMATION SHEET #8

Meat Curing

1. Functions of Curing — The following functions of meat curing are considered to be the most important economically:

   a. Color development (internal and external)
   b. Flavor development
   c. Preservation
   d. Shelf-life extension

2. How meat curing preserves food — Meat curing is considered a bacteriostatic process, which creates an unfavorable environment for microbial growth. Most bacteria, yeasts, and molds that cause food spoilage have a relatively low tolerance to salt (NaCl). Salt acts as a dehydrating agent, osmotically lowering the water content of bacterial organisms and thus limiting their ability to thrive and reproduce. However, there are numerous spoilage and pathogenic (disease-causing) bacteria that can tolerate the salt levels present in most cured products (2 to 4 percent). These organisms are collectively referred to as halophilic (salt-loving) organisms.

   The microbiological safety that is assured from nitrite addition in cured meats is perhaps the most important function of the curing process. Nitrite is the most effective antibotulinal agent known to humans in the prevention of the food poisoning botulism.

3. Meat-Curing Ingredients

   a. Salt (NaCl) — most important of curing ingredients. It makes up the bulk of the curing mixture, not only because it is a good preservative, but also because it provides a desirable flavor.

   b. Sugar — secondary ingredient in curing formula; counteracts the harsh quality of the salt, enhances product flavor, and assists in lowering pH of the cure.

   c. Nitrite and nitrate — essential ingredient in cured meats because of following vital functions:

      1) Prevents botulism and has other bacteriostatic properties to safeguard against mishandling of meat by manufacturers, distributors, retailers, or consumers.

      2) Produces color fixation of meat pigments, which results in characteristic cured pink color.

      3) Retards lipid oxidation which would otherwise cause an undesirable flavor.

      4) Provides characteristic cured flavor.

   d. Sodium erthorbate and ascorbate — hasten color production due to a chemical reaction with nitrite by either producing more nitric oxide or reducing metmyoglobin to myoglobin.

   e. Alkaline phosphates — decrease shrinkage in smoked meat and meat products and the "cook-out" in canned meat products. Their ability to increase the water-binding quality of meat results in increased yields of up to 10 percent.

   f. Spices and flavorings — used to season cured-meat products to give them unique flavor characteristics.

   g. Water — primary functions include:

      1) Acts as a dispersing medium for salt, nitrite, sugar, phosphates, and other ingredients.

      2) Assists in maintaining moist, juicy product.

      3) Compensates for moisture loss during thermal processing.

      4) Reduces product cost by allowing for the merchandising of products which have water levels greater than were naturally present in the raw meat.

INFORMATION SHEET #9

Methods of Meat Curing

1. Dry Salt Cure — This is the original method employed by our ancestors, who practically had to pick the salt out of their teeth. It involves the rubbing and packing of meat in salt for considerable periods of time. The only use of this method today is production of salt pork.

2. Dry Sugar Cure (Dry Country Cure) — In this method the process of making the curing formula consists of mixing 8 pounds of table or curing salt, 3 pounds of cane sugar, 2 ounces of nitrate, and 1 ounce of sodium or potassium nitrite. For each pound of pork 1 ounce of cure is used. Three separate rubbings are required for hams at three- to five-day intervals; two rubbings for picnics and butts; and one thorough rubbing for bacon, with a light sprinkling over the flesh side of each bacon after it is rubbed.

   The length of curing period is seven days per inch of thickness.

3. Hot Salt Cure — Rub cushion side and butt of ham with saltpeter (1 ounce). Follow immediately with rubbing of granulated or brown sugar over entire ham. Allow ham to absorb ingredients for several hours. Then heat sufficient salt so that it is uncomfortable to hands (wear cotton gloves). Place ham in hot salt and cover for five minutes to get ham in soft condition. Take a clean, round, pencil-size stick, and force hot salt into the aitch bone joint. Give ham thorough rubbing with hot salt.

   Allow hams to absorb cure for five to seven days, rub with black pepper, and smoke.

4. Sweet Pickle Cure — A combination of salt and water is called a brine or pickle. The best temperature for curing is from 35° to 40°F. Following is the curing schedule for different strengths of sweet pickle:

85% pickle cure	9 days per inch
75% pickle cure	11 days per inch
60% pickle cure	13 days per inch

1300

INFORMATION SHEET #10

Nitrates and Nitrites Controversy

Sodium nitrate and nitrite have been used for centuries in curing of meat.

During the late 1960s it was found that nitrite can react with certain amine compounds in the intestine, and under other conditions, to form nitrosamines. Nitrosamines are strong carcinogens. Intensive testing followed for the presence of nitrosamines. Generally they were absent or present at very low levels depending upon the product and the methods of cooking.

Considerable pressure was put on the FDA to ban the use of nitrates and nitrites. Several arguments against such a ban have been offered. Many vegetables naturally contain nitrates, which when eaten are reduced to nitrites by the action of bacteria in the mouth. Human saliva normally contains nitrite in excess of the amounts consumed from cured meats. Nitrites presents a risk-benefit dilemma. The FDA and USDA have permitted continued use of nitrates and nitrites but lowered the use levels in some products. They are also encouraging research on alternative ways of preserving meats.

INFORMATION SHEET #11

Fermentation Defined

Describing the End Products Definition

FERMENTATION REFERS TO BREAKDOWN OF CARBOHYDRATE AND CARBOHYDRATE-LIKE MATERIALS UNDER EITHER ANAEROBIC OR AEROBIC CONDITIONS.

Chemical Change Definition

FERMENATION DESCRIBES THE BREAKDOWN OF CARBOHYDRATE MATERIALS UNDER ANAEROBIC CONDITIONS.

INFORMATION SHEET #12

How Certain Foods are Commonly Preserved

1. Fruits and Vegetables
   a. Blanching
   b. Concentration
   c. Sterilization
   d. Freezing/Chilling
   e. Irradiation
2. Milk and Dairy Products
   a. Concentrated
   b. Sterilization/Pasteurization
   c. Dried Products
   d. Fermentation (cheese, yogurt, sour cream, etc.)
3. Meat, Poultry, and Fish
   a. Curing/Smoking
   b. Freezing/Chilling
   c. Canning/Sterilization
   d. Pasteurization
   e. Drying
   f. Irradiation
4. Alcoholic and Non-Alcoholic Beverages
   a. Fermentation
   b. Dried (coffee, coffee creamers, tea, etc.)
   c. Concentrated (juices, etc.)
   d. Carbonation (soda, etc.)

TRANSPARENCY MASTER #1

Preservation Defined

Preservation is to prepare food in a manner that allows it to be safely stored for later use.

TRANSPARENCY MASTER #2

Basic Principles of Food Preservation

I. Two simple rules for food kept for short periods of time

   A. Keep food alive as long as possible.
   B. If the food must be killed, clean it, cover it, and cool it as quickly as possible.

II. Long Term Preservation

   A. Heat:
      1. Sterilization — Inactivation of all microbial forms of life in the food; sealing prevents recontamination.
      2. Other (baking, pasteurization, smoking, frying) — Inactivation of many viable microorganisms.
   B. Cold:
      1. Freezing — Solid water in food inaccessible to microorganisms for growth.
      2. Refrigeration — Microbial growth retarded by low temperature.
   C. Drying — Removes water necessary for growth of microorganisms.
   D. Acids, Sugar, and Salt — Lowering of pH and/or water activity below microbial growth tolerance limits by adding an applicable agent.
   E. Chemicals — Altering the environment to prevent microbial growth and reactions that affect appearance and palatability (i.e. oxidation).
   F. Radiation — Using rays emitted by radioactive elements or streams or electrons to kill microbes present.

TRANSPARENCY MASTER #3

Effect of Environmental Factors on Growth of Microorganisms

Environmental Factor	*Microorganism Type*	*Growth Requirements*
Acidity	All	Approximate range of tolerance pH 4 - pH 8; specific for specific organisms; some microbes very acid-tolerant
Nutrients	All	Wide range of requirements
Oxygen	Aerobic	O_2 required
	Anaerobic	Absence of O_2 required
Temperature	Psychrophilic	Will grow at refrigerated temperatures
	Mesophilic	20 - 36°C
	Thermophilic	40 - 55°C
Water[a]	Bacteria	$a_w = 0.9$ or higher
	Yeasts	$a_w = 0.88$ or higher (some will grow at $a_w = 0.7$)
	Molds	$a_w = 0.8$ or higher (some will grow at $a_w = 0.6$)

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[a] The effect of water is usually expressed in terms of water activity (a_w).

TRANSPARENCY MASTER #4

Degrees of Preservation by Heat

1. Sterilization
2. Commercially Sterile
3. Pasteurization
    a. Destroy Pathogens with Health Significance
    b. Extend Shelf Life
4. Blanching

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TRANSPARENCY MASTER #5

Heating Before or After Packaging

1. Heating Food in Containers
    - a. Still Retort
    - b. Agitating Retorts
    - c. Direct Flame Sterilization
    - d. In-Package Pasteurization
2. Heating Food Before Packaging
    - a. Batch Pasteurization
    - b. High Temperature-Short Time Pasteurization (HTST)
    - c. Aseptic Canning
    - d. Hot Pack or Hot Fill
3. Three-Piece Tin Can

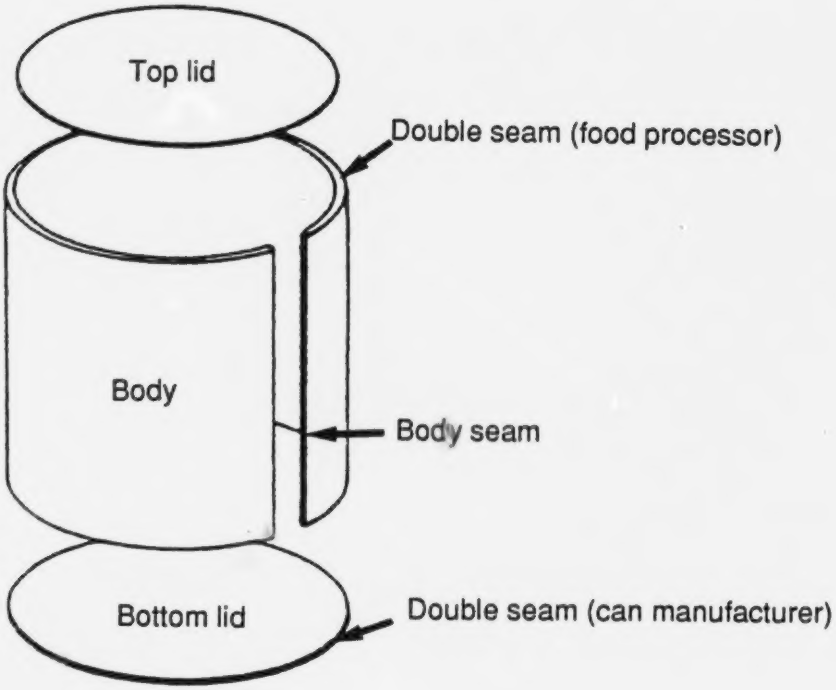
TRANSPARENCY MASTER #6

Technological Principles of Heat Sterilization and Canning of Food

Equipment or Process	*Principle*
Still Retort	Pressurized vessel vertical or horizontal; steam or superheated water heats immobile sealed containers.
Agitated Retort	Containers are rotated (end-over-end or axially) inside the retort during heating.
Hydrostatic Sterilizer	Endless retort, cans carried by conveyor through heating tower with steam, "sealed" by hydrostatic legs of water for heating or cooling.
Steri-Flame Process	Cans heated rapidly by rotating above direct flame.
Pouch-Pack Process	Food products packaged in flexible laminated plastic containers sterilized in pressurized vessels.
UHT Process	Sterilization of fluid foods outside the container, followed by packaging under sterile conditions.
Aseptic Canning	Aseptic filling into pre-sterilized cans following UHT processing.

TRANSPARENCY MASTER #7

The Standard 3-Piece Can


Top lid
Double seam (food processor)
Body
Body seam
Bottom lid
Double seam (can manufacturer)

Diagramatic representation of sanitary can production.

1310

TRANSPARENCY MASTER #8

Freezing Operation Principles

Freezing Operation	*Freezing Rate*	*Principle*
Sharp Freezing	Slow	Food placed in enclosed low temperature environment
Air Blast	Intermediate	Food placed into cold air stream in a tunnel
Fluidized Bed	Intermediate	Using cold air in a fluidized bed
Contact Plate	Slow to Intermediate	Two plates cooled by liquid freezant pressed against rectangular packages
Scraped Surface	Intermediate to Fast	A continuously rotating blade scrapes food frozen by adhesion to the inside and outside of a cold cylinder surface
Liquid Immersion	Intermediate to Fast	Immersion of foods (packaged or unpackaged) into a low freezing point liquid (freons, glycerol solutions)
Cryogenic Freezing	Very Fast	A cyrogenic liquid (liquid N_2 or CO_2) is sprayed on the food

TRANSPARENCY MASTER #9

Drying Operation Principles

Operation	*Principle*
Fluidized Bed Drying	Used on particle-sized foods; sufficient hot air is provided to suspend the particles in air; allows for better heat transfer
Freeze-Drying	Food is quick frozen and low heat is then applied by conduction or radiation to allow water molecules to be vaporized directly from the solid state and removed by high vacuum
Hot Air Drying	Convection heat evaporates water that is then carried away by a stream of hot air; occurs in closed environment
Roller ("Drum") Drying	Hot steel rolls are coated with liquid or pasty type foods; rotating rollers scrape off the dried material
Spray Drying	A fluid food is injected into a stream of hot air, producing a dry powder that is separated mechanically
Sun Drying	Water from food to surrounding air by the radiant heat of the sun
Vacuum Drying	Conducted or radiated heat evaporates water and the vapor is removed by vacuum

TRANSPARENCY MASTER #10

Food Sterilization by Irradiation

Food	*Irradiation Effect*	*Country Allowed*
Underground Vegetables	Sprouting inhibited	Holland, Belgium
Strawberries, Mushrooms	Increased storage time	South Africa, France, Holland, Hungary
Meat, Poultry, Seafood	*Salmonella* control, increased storage time	U.S.S.R., Hungary, Poland, Holland, W. Germany
Herbs and Spices	Sterilization	Hungary, Belgium, Israel

TRANSPARENCY MASTER #11

Microwave Applications for Food Processing

The following is a list and brief explanation of uses of microwave heating in the food industry.

1. Baking — Internal heating quickly achieves desired final temperature through the product. Microwaves can be combined with external heating by air or infrared to obtain crust.
2. Concentrating — Microwaves permit concentration of heat-sensitive solutions at relatively low temperatures in relatively short times.
3. Cooking — Microwaves cook relatively larges pieces without high temperature gradients between surface and interior. Well suited for cooking of meals for large-volume feeding in institutions.
4. Curing — Microwaves are effective for glue-line curing of laminates (as in packaging) without direct heating of laminates themselves.
5. Drying — Microwaves selectively heat water with little direct heating of most solids. Drying is uniform throughout the product; moisture gradients are evened. Drying is conducted at low temperatures.
6. Enzyme Inactivation (Blanching) — Rapid uniform heating to the inactivating temperature can control and terminate enzymatic reactions. Microwaves are especially adaptable to blanching of fruits and vegetables without losses of nutrients associated with hot water or steam blanching. Also, it doesn't overcook the outside of the product in order to inactivate core enzymes.
7. Finish-drying — Microwaves remove the last traces of moisture from the interior of the product quickly after most of the water has been removed by conventional heating without overheating the dried material.

8. Freeze-drying — Microwaves have the ability to selectively heat ice crystals in matter. This makes microwaves attractive for accelerating the final stages of freeze-drying.

9. Heating — Heat transfer problems can benefit from microwaves because of their ability to heat in depth without high temperature gradients.

10. Pasteurizing — Microwaves heat a product rapidly and uniformly without the overheating associated with external, high-temperature heating methods.

11. Precooking — Microwaves are well suited for precooking "heat and serve" items because there is no overcooking of the surface and cooking losses can be negligible. When the consumer reheats the food by conventional methods the desired texture and appearance of conventionally cooked items remains.

12. Puffing and Foaming — Quick internal heating by microwaves causes puffing or foaming when the rate of heat transfer is made greater than the rate of vapor transfer out of the product interior. This method could be applied to puffing of snack foods and other materials.

13. Solvent Removal — Solvents other than water are efficiently vaporized by microwaves, permitting removal of solvents at relatively low temperatures.

14. Sterilizing — Where adequate temperatures may be reached, microwaves may permit high temperature-short time sterilization. Cautious application is necessary because temperatures generally are not sufficient to kill bacterial spores.

15. Tempering — Microwaves can equalize moisture in a product that came from a process in a nonuniform condition.

16. Thawing — Controlled rapid thawing of bulk items is possible due to substantial penetration of microwaves into frozen materials.

TRANSPARENCY MASTER #12

Meat Curing

1. Functions of Curing
   a. Color Development
   b. Flavor Development
   c. Preservation
   d. Shelf-Life Extension
2. How Meat Curing Preserves Food
3. Meat Curing Ingredients
   a. Salt
   b. Sugar
   c. Nitrite and Nitrate
   d. Sodium Erthorbate and Ascorbate
   e. Alkaline Phosphates
   f. Spices and Flavorings
   g. Water

TRANSPARENCY MASTER #13

Some Industrial Fermentations in Food Industries

Lactic acid bacteria

- Vegetables and fruits
  - cucumbers → dill pickles, sour pickles, salt stock
  - olives → green olives, ripe olives
  - cabbage → sauerkraut
  - turnips → sauerrüben
  - lettuce → lettuce kraut
  - mixed vegetables, turnips, radish, cabbage → Paw Tsay
  - mixed vegetables in Chinese cabbage → Kimchi
  - vegetables and milk → Tarhana
  - vegetables and rice → Sajur asin
  - dough and milk → Kishk
  - coffee cherries → coffee beans
  - vanilla beans → vanilla
  - taro → poi
- Meats → sausages such as salami, Thuringer, summer, pork roll, Lebanon bologna, cervelat
- Dairy products
  - sour cream
  - sour milk drinks → acidophilus, yogurt, cultured buttermilk, Bulgarian, skyr, gioddu, leban, dadhi, taette, mazun
  - butter → sour cream butter, cultured butter, ghee
  - cheese—unripened → cottage, pot, schmierkase, cream
    - —whey → mysost, primost, ricotta, schottengsied
    - —ripened → Cheddar, American, Edam, Gouda, Cheshire, provolone

Lactic acid bacteria with other microorganisms

- Dairy products
  - with propionic acid bacteria — Emmenthaler, Swiss, Samso, Gruyere cheeses

with surface-ripening bacteria — Limburger, brick, Trappist,
Münster, Port de Salut
with yeasts — kefir, kumiss or kumys
with molds — Roquefort, Camembert, Brie, hand, Gorgonzola,
Stilton, Blue
Vegetable products
with yeasts — Nukamiso pickles
with mold — tempeh, soya sauce

Acetic acid bacteria — wine, cider, malt, honey, or any alcoholic and sugary or starchy products may be converted to vinegar

Yeasts
malt → beer, ale, porter, stout, bock, Pilsner
fruit → wine, vermouth
wines → brandy
molasses → rum
grain mash → whiskey
rice → sake, sonti
agave → pulque
bread doughs → bread

Yeasts with lactic acid bacteria
cereal products → sour dough bread, sour dough pancakes, rye bread
ginger plant → ginger beer
beans → vermicelli

Yeasts with acetic acid bacteria
cacao beans
citron

Mold and other organisms
soybeans — miso, chiang, su fu, tamari sauce, soy sauce
fish and rice — lao, chao

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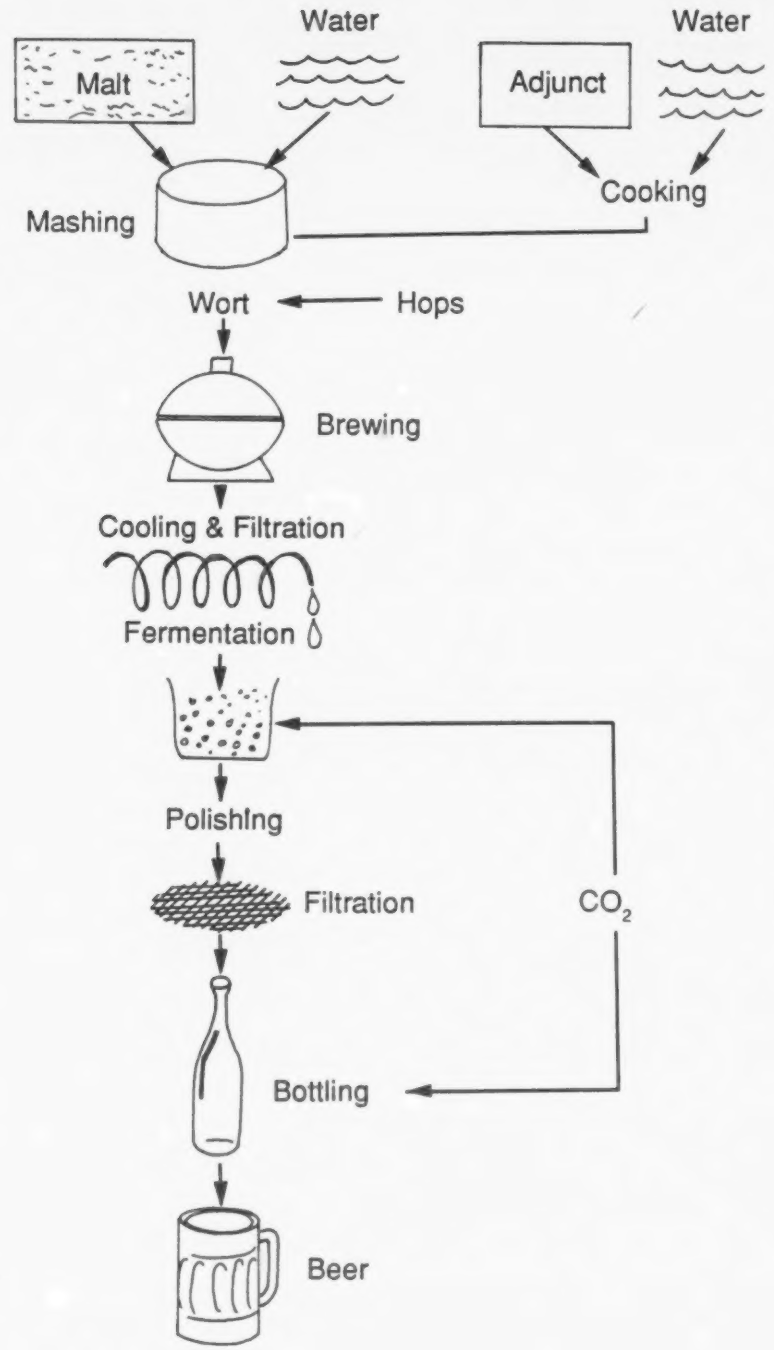
TRANSPARENCY MASTER #14

Schematic Illustration of the Brewing Process


Water
Water
Malt
Adjunct
Cooking
Mashing
Wort
Hops
Brewing
Cooling & Filtration
Fermentation
Polishing
Filtration
CO_2
Bottling
Beer

STUDENT ACTIVITIES

STUDENT WORKSHEET #1 — Degrees of Preservation by Heat Word Search (with solution)

STUDENT WORKSHEET #2 — Preservation by Heat and Cold

STUDENT WORKSHEET #3 — The Effect of Heat and pH on the Color and Texture of Green Vegetables Laboratory Exercise

STUDENT WORKSHEET #4 — Principles of Dehydration of Foods

STUDENT WORKSHEET #5 — The Science of Meat Curing Laboratory Exercise

STUDENT WORKSHEET #6 — Tumbling of Cured Muscle Tissue Laboratory Exercise

STUDENT WORKSHEET #7 — The Effect of Curing on Meat Color Laboratory Exercise

STUDENT WORKSHEET #8 — Oxidative Rancidity Laboratory Exercise

STUDENT WORKSHEET #9 — The Effect of Refrigerated Storage of Color Formation in Potato Chips and French Fries Laboratory Exercise

For additional activities, teachers may refer to the "Suggested Teaching Activities and Procedures" section in the Instructor's Guide.

STUDENT WORKSHEET #1

Degrees of Preservation by Heat Word Search

E	U	C	I	L	I	H	P	O	M	R	E	H	T	V	Q	A	J	Y	H
O	M	C	O	T	E	M	P	E	R	A	T	U	R	E	S	D	J	E	I
G	I	P	I	U	B	A	N	U	D	E	W	V	D	T	M	M	A	D	I
J	W	S	E	L	Q	L	J	E	M	M	S	W	E	Z	I	T	R	G	S
F	P	Y	V	I	I	U	A	D	V	E	W	R	U	C	C	L	Y	E	I
D	O	C	P	N	D	H	X	N	M	V	I	L	R	T	R	G	L	L	U
Q	D	H	P	I	U	V	P	Y	C	L	B	O	F	K	O	L	I	I	N
M	P	R	Z	A	L	L	Z	O	I	H	B	W	N	Z	O	J	C	R	Q
R	Q	O	S	Y	S	N	S	Z	S	I	I	O	M	E	R	I	M	E	W
Y	I	P	X	V	E	T	A	M	A	E	I	N	M	P	G	B	H	T	G
B	P	H	D	S	E	T	E	L	S	T	M	I	G	C	A	L	F	S	V
V	J	I	F	S	I	G	M	U	A	I	L	Z	P	T	N	R	B	H	E
N	C	L	G	O	N	D	E	V	R	K	N	Q	F	X	I	K	A	E	O
G	L	I	N	A	F	E	R	T	P	I	Q	A	B	P	S	G	C	I	G
N	N	C	Y	K	G	E	G	S	A	W	Z	J	G	Z	M	I	T	L	O
F	R	U	I	T	S	D	C	O	N	B	Q	A	L	R	S	A	E	W	G
E	L	B	N	E	I	Q	U	O	H	I	L	R	T	J	O	Q	R	G	A
E	R	A	R	L	C	R	B	M	K	T	X	E	P	I	Y	A	I	R	O
C	Y	P	E	O	W	L	J	Z	T	K	A	O	S	U	O	A	A	W	X
F	J	M	H	R	J	E	C	M	G	Z	T	P	T	S	N	N	T	W	I

The following words are hidden in the puzzle:

Bacteria
Blanching
Enzymes
Fruits
Heat
Mesophilic
Microbial
Microorganisms
Milk
Organisms

Pasteurization
Pathogens
Preservation
Psychrophilic
Sterile
Sterilization
Temperature
Thermophilic
Toxins
Vegetables

STUDENT WORKSHEET #1 — Key

Degrees of Preservation by Heat Word Search

•	•	C	I	L	I	H	P	O	M	R	E	H	T	•	•	•	•	•	H
•	•	C	•	T	E	M	P	E	R	A	T	U	R	E	S	•	•	E	•
•	•	P	I	•	B	•	•	•	•	•	•	•	•	T	M	M	A	•	•
•	•	S	•	L	•	L	•	•	•	•	S	•	E	•	I	T	•	•	•
•	•	Y	•	•	I	•	A	•	•	E	•	R	•	C	C	•	•	E	•
•	•	C	•	•	•	H	•	N	M	•	I	•	R	•	R	•	•	L	•
•	•	H	P	•	•	•	P	Y	C	L	•	O	•	•	O	•	•	I	•
•	•	R	•	A	•	•	Z	O	I	H	B	•	N	•	O	•	•	R	•
•	•	O	•	•	S	N	S	Z	S	I	I	O	•	•	R	•	•	E	•
•	•	P	•	V	E	T	A	M	A	E	I	N	M	•	G	•	•	T	•
•	•	H	•	•	E	T	E	L	S	T	M	I	G	•	A	•	•	S	•
•	•	I	•	S	I	G	•	U	A	I	L	•	•	•	N	•	B	•	•
•	•	L	•	O	N	•	E	V	R	K	N	•	•	•	I	•	A	•	•
•	•	I	N	•	•	E	R	T	•	I	•	A	•	•	S	•	C	•	•
•	•	C	•	•	•	E	G	S	A	•	Z	•	G	•	M	•	T	•	•
F	R	U	I	T	S	•	•	O	N	B	•	A	•	R	S	•	E	•	•
•	•	•	•	E	•	•	•	•	H	I	L	•	T	•	O	•	R	•	•
•	•	•	R	•	•	•	•	•	•	T	X	E	•	I	•	•	I	•	•
•	•	P	•	•	•	•	•	•	•	•	A	O	S	•	O	•	A	•	•
•	•	•	•	•	•	•	•	•	•	•	•	P	T	•	•	N	•	•	•

The following words are hidden in the puzzle:

Bacteria
Blanching
Enzymes
Fruits
Heat
Mesophilic
Microbial
Microorganisms
Milk
Organisms
Pasteurization
Pathogens
Preservation
Psychrophilic
Sterile
Sterilization
Temperature
Thermophilic
Toxins
Vegetables

STUDENT WORKSHEET #2

Preservation by Heat and Cold

Match the terms in the left column with their correct definition in the right column.

1. ________ Still Retort
2. ________ Aseptic Canning
3. ________ Agitated Retort
4. ________ UHT
5. ________ Cryogenic Freezing
6. ________ Sharp Freezing
7. ________ Air Blast
8. ________ Liquid Immersion
9. ________ Sterilization
10. ________ Blanching
11. ________ Thermophilic
12. ________ Psychrophilic
13. ________ Mesophilic

A. Will grow at refrigerated temperatures.
B. Refers to complete destruction of microorganisms.
C. Immediate to fast freezing rate; packaged or unpackaged foods immersed into cold liquid of a low freezing point.
D. Sealed container heated by steam without movement.
E. Special UHT processing.
F. Grows at 40-55°C.
G. Generally applied to fruits and vegetables to inactivate natural food enzymes.
H. Slow freezing rate; food placed into still air of low temperature.
I. Heat sterilization of fluid foods outside the package, followed by packaging under sterile conditions.
J. Food container rotated end-over-end during heating.
K. Grows at 20-36°C.
L. Very fast freezing rate; food sprayed with a cryogenic liquid of extremely low boiling point.
M. Food placed into stream of circulating cold air in a tunnel; intermediate freezing rate.

STUDENT WORKSHEET #2 — Key

Preservation by Heat and Cold

Match the terms in the left column with their correct definition in the right column.

1. ___D___ Still Retort
2. ___E___ Aseptic Canning
3. ___J___ Agitated Retort
4. ___I___ UHT
5. ___L___ Cryogenic Freezing
6. ___H___ Sharp Freezing
7. ___M___ Air Blast
8. ___C___ Liquid Immersion
9 ___B___ Sterilization
10. ___G___ Blanching
11. ___F___ Thermophilic
12. ___A___ Psychrophilic
13. ___K___ Mesophilic

A. Will grow at refrigerated temperatures.
B. Refers to complete destruction of microorganisms.
C. Immediate to fast freezing rate; packaged or unpackaged foods immersed into cold liquid of a low freezing point.
D. Sealed container heated by steam without movement.
E. Special UHT processing.
F. Grows at 40-55°C.
G. Generally applied to fruits and vegetables to inactivate natural food enzymes.
H. Slow freezing rate; food placed into still air of low temperature.
I. Heat sterilization of fluid foods outside the package, followed by packaging under sterile conditions.
J. Food container rotated end-over-end during heating.
K. Grows at 20-36°C.
L. Very fast freezing rate; food sprayed with a cryogenic liquid of extremely low boiling point.
M. Food placed into stream of circulating cold air in a tunnel; intermediate freezing rate.

STUDENT WORKSHEET #3

The Effect of Heat and pH on the Color and Texture of Green Vegetables Laboratory Exercise

Background

Cell Wall Structure

The cell is the basic structural unit of all plant tissues. These cells are surrounded by cell walls that provide an elastic support for retaining the contents of the cell. The cell also has a cell membrane layer, which is located just inside the cell wall and which controls the passage of liquids into and out of the cell. The cell is filled with a gel-like substance, termed the cytoplasm, which is composed of protein, sugars, salts, and other substances dispersed in water. Mature cells also contain vacuoles, which are separate compartments filled with a fluid, cell-sap, and which are composed of dissolved sugars, salts, organic acids, pigments, and other materials. Also located within the cytoplasm are separate inclusion bodies, called plastids, which contain the pigment chlorophyll. These plastids are only about 4 to 10 nm in diameter.

Pigments

Green vegetables contain the green pigment chlorophyll, which plays a key role in transferring light energy to chemical energy during the growth and development of the plant by the process of photosynthesis. Examples of such green vegetables include spinach, peas, beans, cabbage, lettuce, and celery.

Vegetables Processing

It is necessary to process green vegetables to preserve them for a year-round food source. The most common commercial method of preservation is canning. For this process, the vegetables are cleaned, trimmed, cut, packed into cans, sealed, and heated to sufficiently high temperatures (in the order of 240°F) to destroy spoilage- and disease-causing microorganisms. Such heat treatments also produce a number of undesirable chemical and textural changes in the vegetables. The textural changes are due to partial destruction of the cell wall and cell membrane. Heat treatments also cause chemical alteration of the green pigment chlorophyll, thus resulting in a processed vegetable with less green color. It is important for the food processor to control pH of the water added to the vegetables prior to canning. Most processes require that the pH be near neutral (about 6 to 7) to minimize the adverse chemical reactions that cause loss of texture and color acceptability of the canned green vegetables.

pH Definition

There are a number of definitions of pH, but for our purposes the degree of acidity or alkalinity of a solution is usually measured in terms of the pH scale. A neutral solution (contains equal concentrations of acid and alkali) has a pH of 7. Acidic solutions have pH values below 7 and alkaline solutions have pH values above 7. The lower the pH value the stronger the acid concentration and the higher the pH value above 7, the stronger the alkali concentration in the solution.

Experimental

In this experiment you will investigate the effect of heat and pH upon the color and texture of green beans. The pH of the solution will be adjusted to alkaline and acidic conditions, but the heating time and all other conditions will be held constant.

Materials

1. Fresh or frozen green beans
2. Dilute HCl solution (.01N HCl)
3. Dilute NaOH solution (.01N NaOH)
4. Distilled water or tap water
5. Bunson burner
6. Timer or wall clock
7. 250 ml beakers with watch glasses
8. 100 ml graduated cylinders
9. Weighing balance
10. 12- to 15-cm filter paper discs
11. Stirring rods or magnetic stirrer
12. Heat resistant gloves or tongs
13. Spatula or table fork
14. Litmus paper strips or pH indicating paper
15. Marking pen

Procedure

1. Label four beakers, cylinders, and filter paper discs:
    a. 0.01N HCl
    b. 0.01N NaOH
    c. Heated control (distilled or tap water)
    d. Unheated control (distilled or tap water)
2. Weigh about 20 grams of green beans into each of the four beakers.
3. Add 100 ml of the above solutions or water to the labeled beakers.
4. Cover the beakers with a watch glass. Stir occasionally with a glass rod or continuously at a slow speed with a magnetic stirrer.
5. Heat each of the beakers to maintain a slow boil (simmer) for exactly 15 minutes. Do not heat the unheated control.
6. Observe and record changes in the appearance of the beans and the solutions in each beaker during the heating treatment.
7. Allow the beakers to cool and then drain the solutions into the labeled graduated cylinders. Drain the unheated control beaker into the labeled graduated cylinder.
8. Pour the drained beans onto the corresponding labeled filter paper discs.
9. Determine and record the pH of each cooking solution and also of the water in the unheated control in the table provided.
10. Observe and record the color characteristics and also color intensity for each drained solution.
11. Observe the changes in texture (firmness) of each of the green beans by crushing or cutting them with a spatula or table fork. Record these data also in the table provided.

Questions

1. What is the temperature of water used for heating the beans in your experiment? How does this temperature compare with that used for commercial processing of vegetables?
2. Which of your solutions were near neutral? Acidic? Alkaline?
3. Which pH solution provided the best color and texture retention?
4. Which pH solution provided the poorest color retention?
5. What pigment is responsible for the observed changes in color of the cooked vegetables?
6. What reactions are responsible for loss of texture in cooked green beans?

Vocabulary of Technical Terms

1. Pigment
2. Chlorophyll
3. Acid
4. Alkali
5. Acidic
6. Alkalinity
7. pH
8. Litmus paper or pH indicator paper
9. nm (nanometer)
10. Color
11. Texture

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Treatment	pH	Color				Texture
		Drained Solution		Drained Beans		
		Characteristic	Intensity Scale (0 to 10)	Characteristic	Intensity Scale (0 to 10)	(Scale 1 to 10)
Unheated Control						
Heated Control						
Acetic Acid						
Sodium Bicarbonate						

Taken from *Experiments in Food Science.* Institute of Food Technologists, 221 N. LaSalle Street, Chicago, IL 60601. Single copies, along with a Teacher's Guide, of the complete booklet can be received at no charge.

STUDENT WORKSHEET #4

Principles of Dehydration of Foods

Match the food dehydration method with its appropriate description.

1. ________ Sun Drying
2. ________ Spray Drying
3. ________ Freeze-drying
4. ________ Roller ("drum") drying
5. ________ Vacuum Drying
6. ________ Hot Air Drying
7. ________ Fluidized Bed Drying

A. Water removed by sublimation from frozen foods under high vacuum; heat must be supplied by conduction or radiation through the dry food layer.

B. Liquid or pasty foods applied on surface of hot stainless steel rolls; dry material scraped off the rotating rolls at the end of a revolution.

C. A special case of hot air drying; beds of particulate foods airlifted by hot air for better heat and mass transfer.

D. Removal of water vapor by creation of vacuum; heat must be supplied by conduction or radiation (no air used!).

E. Radiant heat from the sun evaporates water from food to surrounding air.

F. Stream of hot air in closed environment supplies heat by convection and carries away the evaporated water.

G. Special case of hot air drying; fluid foods sprayed into the stream of hot air; dry powder separated mechanically.

STUDENT WORKSHEET #4 — Key

Principles of Dehydration of Foods

Match the food dehydration method with its appropriate description.

1. E Sun Drying
2. G Spray Drying
3. A Freeze-drying
4. B Roller ("drum") drying
5. D Vacuum Drying
6. F Hot Air Drying
7. C Fluidized Bed Drying

A. Water removed by sublimation from frozen foods under high vacuum; heat must be supplied by conduction or radiation through the dry food layer.

B. Liquid or pasty foods applied on surface of hot stainless steel rolls; dry material scraped off the rotating rolls at the end of a revolution.

C. A special case of hot air drying; beds of particulate foods airlifted by hot air for better heat and mass transfer.

D. Removal of water vapor by creation of vacuum; heat must be supplied by conduction or radiation (no air used!).

E. Radiant heat from the sun evaporates water from food to surrounding air.

F. Stream of hot air in closed environment supplies heat by convection and carries away the evaporated water.

G. Special case of hot air drying; fluid foods sprayed into the stream of hot air; dry powder separated mechanically.

STUDENT WORKSHEET #5

The Science of Meat Curing Laboratory Exercise

Background

The science of food processing is intriguing and challenging. Although meat processing is commonly practiced in industry, it is not clearly understood by the majority of consumers. This stimulates tremendous curiosity. Meat curing is an example of meat processing procedures, and daily we enjoy the results.

A traditional red color is associated with cured meat in products such as smoked ham, bacon, and weiners. A brown color develops as fresh "uncured" meat is cooked. The principle difference is that the red product has been cured. The color of meat is dependent upon the muscle pigment known as myoglobin just as the red color of blood comes from the pigment called hemoglobin.

Fresh pork may be cured for the purpose of preservation but of greater importance today is the pleasing palatability and the variety in our diet which cured pork provides. A study of curing agents is fascinating. Salt adds flavor, slightly dehydrates the meat and has a preservative effect through its dehydrating action on bacteria. A sweetening agent may be used to contribute flavor. The compounds resulting from sodium nitrite reduction react with myoglobin, the muscle pigment, to establish the color change from the grayish pink color of fresh pork to the red color of cured pork. A few specialty items are cured by applying the dry ingredients to the surface of the meat. These dry ingredients go into dilution with the normal moisture in the meat and permeate through the piece by means of osmosis. Modern technology suggests dissolving the curing ingredients in water and injecting them into the meat for rapid and controlled processing.

Problem

This project is designed to investigate one method of pork curing with the amount of sodium nitrite and temperature as variables. What are the differences in color change when sodium nitrite or temperature are changed? Is there a difference if sodium nitrate is substituted for sodium nitrite?

Materials and Methods

Cubes of fresh pork, measuring 5 inches or more on a side, from the fresh ham or shoulder, serve the purpose. Prepare curing mixtures using these formulas: 25.0 grams salt (NaCl), 9.0 grams sweetening agent (brown sugar), .025, .05, 0.1, or 0.2 grams sodium nitrite. To ensure uniform distribution, mix dry ingredients, and finally add moist or sticky ingredients such as brown sugar. (An alternative to obtaining each curing ingredient and mixing them is to use a commercial curing mixture available in some store. (One such product is Morton's Sugar Cure.) Rub the curing mixture over the surface of the pork cube at the rate of 25 grams per pound of pork meat. Store each cube in a glass or plastic container at approximately 40°F. As an alternative experiment, store each cube at room temperature. Apply the curing ingredients to a different cube of pork on successive days so that on a given day you can, by cutting the cubes in half, show the changes that occur in 24, 48, and 72 hours as the myoglobin is converted to nitrosomyoglobin. Heating the pork to 150°F will produce the characteristics of cooked pork and convert the nitrosomyoglobin to nitrite oxide hemochrome, a more stable pigment. This will terminate color development and stabilize the color contrast. Protect the finished product from light and oxygen to inhibit color fading.

References:

1. Cahill, Vern R. et al. *Meat Processing*. The Ohio State University.
2. Forrest, John C. et al. *Principles of Meat Science*. San Francisco: W.H. Freeman and Company, 1975.
3. Pearson, A.M. et al. *Processed Meat*. Westport, CT: The AVI Publishing Co., Inc., 1984.
4. Romans, John R. and P. T. Ziegler. *The Meat We Eat*. Danville, IL: The Interstate Printers and Publishers, Inc., 1985.

Submitted by Dr. Vern Cahill, Department of Animal Science, The Ohio State University. Taken from *The Science Workbook of Student Research Projects in Food - Agriculture - Natural Resources.* (1985). Published by the College of Agriculture, The Ohio State University.

STUDENT WORKSHEET #6

Tumbling of Cured Muscle Tissue Laboratory Exercise

Background

Tumbling or massaging of cured muscle tissue results when cured tissue is placed in a rotating drum (similar in construction to a small cement mixer) which picks up the tissue and drops it to the bottom of the drum, or when cured tissue is placed in a vat and stirred with paddles. This procedure was developed in Europe and is currently widely used in the United States for many cured items. Its reported advantages are:

1. Increased yield in curing and cooking.
2. Increased uniformity of color.
3. Increased uniformity of curing ingredients.
4. More tenacious bonding together of small pieces upon cooking; and more attractive slice upon slicing.
5. Increased juiciness of final product.

Problem

Many questions relating to tumbling could be studied. Examples of these might include:

1. Amount of cure solution the tissue will hold.
2. Appropriate temperature of tumbling.
3. Influence of tumbling time or tumbling speed.
4. Comparison of continuous versus intermittent tumbling.
5. Influence of various additives and/or level of additives.

Many items could also be measured to see the influence of the tumbling. These might include, but are not limited to:

1. Curing yield
2. Cooking yield
3. Cohesiveness of cooked slices
4. Color uniformity
5. Juiciness
6. Tenderness
7. Temperature during tumbling
8. Microbial growth during tumbling

Materials and Methods

To conduct research in this area a miniature tumbler or massager will be needed. This can be as simple as a container shaken by hand for 10 minutes per hour or as complex as a rotary rock polishing device or a paddle stirrer. Some preliminary research will be needed or practice required to insure that, while operating the tumbler, the mechanical action physically manipulates the meat but does not tear up the tissue.

A curing solution will also be needed and it usually consists of:

Quantity of Meat	Ingredient
20 % pump	Water
2%	Salt
156 p.p.m.	Sodium Nitrite
1%	Sugar
0.5%	and sometimes phosphates

References

1. Knipe, C. L. et al. "Effect of Tumbling and Tumbling Temperature on Total Aerobic Plate Counts (Incubated at 25°C) and Quality of Boneless, Cured Hams." *Journal of Food Science* 46 (1981): 212.

2. Krause, R. J. et al. "Influence of Tumbling, Tumbling Time, Trim and Sodium Tripoloyphosphate on Quality and Yield of Cured Hams." *Journal of Food Science* 43 (1978): 853.

3. Ockerman, H. W., C. S. Organisciak. "Influence of Continuous Versus Intermittent Tumbling on Brine (Salt, Sugar and Nitrite) Diffusion in Porcine Tissue." *Journal of Food Protection* 41 (1978): 878.

Submitted by Dr. Herbert Ockerman, Department of Animal Science, The Ohio State University.Taken from *The Science Workbook of Student Research Projects in Food - Agriculture - Natural Resources.* (1985). Published by the College of Agriculture, The Ohio State University.

STUDENT WORKSHEET #7

The Effect of Curing on Meat Color Laboratory Exercise

Introduction

Historically, salt (sodium chloride) was used for the preservation of meat. The resulting product was usually gray in color unless the sodium chloride happened to be contaminated with $NaNO_3$ (sodium nitrate). In this case the meat developed the characteristic red color which we presently associate with so-called cured or processed meats such as hams, bacons, hotdogs, bologna, etc. Eventually, nitrates were deliberately added to the salt to produce the desired color. With the ultimate discovery that nitrates were effective for color development only after reduction to nitrites (NO_2), nitrites were added to the curing formula.

The curing process for meats involves introduction of the curing materials (salt, sugar, nitrite, spices) into the product either by injection, which is the case with hams or bacon, or by direct addition to the ground meat mixture, which is the case with various types of sausage products such as hotdogs.

After initial processing, these meats are generally smoked to develop a characteristic flavor and color.

Purpose

1. To observe the differences in color between fresh red meat with and without sodium nitrite added, and observe the changes in each after heating.

Materials

1. hamburger
2. 150 ml beakers
3. sodium nitrite
4. plastic bag
5. hot water or steam bath.

Procedure

1. Divide 200 g of freshly ground hamburger into two parts of 100 g each.
2. Put one of the batches of hamburger into a plastic bag and add 0.016 g sodium nitrite ($NaNO_2$) (your teacher will explain how to do this). Mix it thoroughly by kneading the bag for about 3 minutes.
3. Stuff each batch of hamburger into a beaker. Pack it down tightly to get rid of as much air as possible. Cover the beakers with a piece of wax paper or watch glass and label accordingly: with or without nitrite.
4. Examine and record both the surface color and the interior color of each sample. Do not taste either of the samples.
5. Place the beakers in a refrigerator overnight.
6. The next day, remove the beakers from the refrigerator and again examine the surface and interior colors.
7. Heat each beaker over a steam bath or in a boiling water bath for 15-20 minutes.
8. Once again, examine the surface and interior colors in both samples.
9. Record your observations in your notebook as indicated in the following section.

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Data

Constuct table in your notebook similar to the one below.

	Control (No Nitrite)		Experimental (With Nitrite)	
	surface	interior	surface	interior
Before storage				
After storage				
After cooking				

Conclusion

What effect does the addition of sodium nitrite to fresh meat have on the color before and after cooking?

Questions

1. The legal maximum level of nitrite (NO_2) in a finished product is 156 ppm. How much sodium nitrite can you legally add to 1 Kg of meat?
2. Which of the samples after cooking most closely resembles ham or sausage?
3. Which of the cooked samples do you prefer as ham?
4. Would you purchase meats processed without nitrites? Why?

Taken from *Experiments in Food Science.* Institute of Food Technologists, 221 N. LaSalle Street, Chicago, IL 60601. Single copies, along with a Teacher's Guide, of the complete booklet can be received at no charge.

STUDENT WORKSHEET #8

Oxidative Rancidity Laboratory Exercise

Introduction

Like all food components, fats undergo deteriorative changes which result in undesirable flavors and odors with time. These changes in fats are given the term "rancidity." Rancidity can be of two types, hydrolytic and oxidative.

Oxidative rancidity results from oxidation of unsaturated and polyunsaturated fatty acids. The products of these reactions produce undesirable flavors and odors. These flavors sometimes develop in foods such as peanut butter, potato chips, and crackers. In some foods, manufacturers are permitted to add antioxidants which slow down this oxidative deterioration. The antioxidants normally used are butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT) and propyl gallate. You may see these terms on the labels of some foods. Another means of slowing down oxidation is to package the food so that it is protected from light and oxygen, two things that accelerate oxidation.

Hydrolytic rancidity is caused by a breakdown of the fat into glycerol and fatty acids. This is the type of rancidity that gives "rancid" butter its bad flavor.

Purpose

1. To demonstrate typical off-flavors in fat caused by oxidative rancidity and to study one of the factors which causes lipid oxidation.

Materials

1. fresh potato chips
2. pint or quart canning jars with lids
3. aluminum foil.

Procedure

1. Wrap one pint or quart canning jar with aluminum foil and tape in place so that no light can enter the container.
2. Place fresh potato chips in this aluminum foil wrapped jar and in a similar clear jar without aluminum foil around it.
3. Taste the potato chips and rate their flavor on a 5 point scale:

   1 = extremely dislike the flavor
   2 = slightly dislike the flavor
   3 = neither like nor dislike the flavor
   4 = slightly like the flavor
   5 = extremely like the flavor

4. Place the two jars on a window sill where the jars will be exposed to sunlight.
5. Taste potato chips from each jar at 1-2 day intervals for 1-2 weeks. The length of time for this experiment is dependent on the amount of sunlight that the jars are exposed to.
6. Make a graph of your data on the flavor of the potato chips stored these two ways versus storage time. The y-axis should be the flavor score and the x-axis the time in days.

Conclusions

What can you conclude about the effect of packaging material (how a product is packaged) on the flavor of that food?

Questions

1. Why did wrapping the jar in aluminum foil affect the flavor of the stored potato chips?
2. Are potato chips that you purchase in the store packaged in containers that permit light to enter or exclude light?
3. Is there anything else in the atmosphere that we would like to keep away from potato chips while they are in a package?

Taken from *Experiments in Food Science*. Institute of Food Technologists, 221 N. LaSalle Street, Chicago, IL 60601. Single copies, along with a Teacher's Guide, of the complete booklet can be received at no charge.

STUDENT WORKSHEET #9

The Effect of Refrigerated Storage in Color Formation in Potato Chips and French Fries Laboratory Exercise

Introduction

Very few people enjoy eating dark potato chips and french fries not only because of the bad appearance but also because of the burned flavor. Potato processors are very conscious of this fact and try to insure that their products are not overcooked. The burned flavor and dark brown color are a result of complex chemical reactions between protein (amines) and certain types of sugars (reducing sugars), both of which are contained in potatoes.

Purpose

1. To examine one factor which influences color and flavor development in fried potato products.

Materials

1. potato peelers
2. knives
3. cutting board
4. cooking oil
5. deep fat fryer
6. paper towel
7. salt

Procedure

1. Your teacher will provide you with two potatoes, one of which has been stored under refrigeration, the other at room temperature for about two weeks.
2. Peel the potato stored at room temperature and slice it into french fry strips.
3. Fry it in oil at 375°F for 8-10 minutes until golden brown.
4. When done place the french fries on a paper towel to drain.
5. Get the cold-stored potato from the refrigerator and repeat steps 2-4, making sure to fry it immediately after preparation in step 2 and fry it exactly the same length of time. Also cut the strips to the same size as those cut from the potato stored at room temperature.
6. Compare the color of each.
7. Salt lightly as desired, compare the flavor, and, if possible, the texture of each.
8. If a suitable slicer is available, potato chips can be prepared following steps 2-7, substituting potato chip slices for the french fry strips in step 2, and reducing the frying time in step 3, depending on the thickness of the slices. The slice thickness and frying times should be the same for both potato samples.

Conclusion

What can you conclude about the effect of storage conditions on these sensory properties of the french fries?

Questions

1. Which storage condition resulted in french fries that are light in color with no burned flavor?
2. Why did one batch of french fries turn out lighter than the other?

Data

Enter your observations in your notebook in a table similar to the one below.

	Refrigerated	Not refrigerated
Color		
Flavor		
Texture		

Taken from *Experiments in Food Science*. Institute of Food Technologists, 221 N. LaSalle Street, Chicago, IL 60601. Single copies, along with a Teacher's Guide, of the complete booklet can be received at no charge.

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Food Science and Technology

PROBLEM AREA: Adhering to Government Regulations

RELATED PROBLEM AREA(S):

1. Understanding Food Science Technology (Central Core Cluster)
2. Processing Agricultural Products
3. Meeting Nutritional Needs of Food Consumers
4. Packaging and Distributing Food Products

PREREQUISITE PROBLEM AREA(S):

1. Understanding Food Science Technology (Central Core Cluster)

LEVEL: Preparatory

OCCUPATIONAL TASKS ADDRESSED:

Agricultural Business and Management Cluster

Duty R: Applying Safety Practices

1. Participate in safety training program

STATE GOALS FOR LEARNING:

In planning the instruction for this problem area, teachers can promote the development of several student learning objectives which are related to the State Goals for Learning in Social Sciences. These objectives are listed on the Learning Assessment Plan forms included on the following page(s). Those learning objectives marked with an asterisk (*) are taken from the sample lists provided by the Illinois State Board of Education.

Illinois Agricultural Core Curriculum

Agricultural Education 124 Mumford Hall 1301 W. Gregory Drive University of Illinois Urbana, IL 61801

Director: Dale A. Law, Ed.D.
Principal Investigator: Jerry D. Pepple, Ed.D.
Research Assistant: Randy J. Bernhardt

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Submission Date ____________
☐ Original submission ☐ Revision
Page ____ of ____

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

(Affix label or complete district information.)

COUNTY	DISTRICT	ESC

District Name

City

I. LEARNING AREA *(check one)*
☐ Language Arts
☐ Mathematics
☐ Sciences
☐ Fine Arts
☒ Social Sciences
☐ Physical Development/Health

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to apply the skills and knowledge gained in the social sciences to decision making in life situations.

Contact Person: ____________
Title: ____________
Phone: ( )

III. LEARNING OBJECTIVES	IV. ASSESSMENT A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	V. EXPECTATIONS Percent of Students Expected to Achieve Objective
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:					
1. Describe the role of the product development and quality control departments of a food science business.					
2. Understand basic government regulations of the food science industry.					
3. Recognize and understand federal grade standards of food.					
*4. Analyze the complex relationships existing among individual consumers, business, industry, and governmental entities.					

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INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Food Science and Technology

PROBLEM AREA: Adhering to Government Regulations

STUDENT LEARNING OBJECTIVES

Upon the completion of their study of this problem area, students will be able to:

1. Describe the role of the product development and quality control departments of a food science business.
2. Understand basic government regulations of the food science industry.
3. Recognize and understand federal grade standards of food.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Food Science and Technology

PROBLEM AREA: Adhering to Government Regulations

PROBLEMS AND QUESTIONS FOR STUDY	INSTRUCTOR'S NOTES AND REFERENCES

1. What is the function of the product development department of a food science business?

2. What is the role of the quality control department of a food science business?

3. What is the organizational structure of a food science firm and where do the product development and quality control departments fit into this organizational structure?

4. What are the main functions of a quality control department in the food industry?

5. What are some routine quality control procedures used in the food industry?

6. What governmental agencies regulate the food industry? What are their responsibilities related to food processing?

7. What are some of the rules and regulations that the Food and Drug Adminstration uses to administer various food laws?

8. What is adulteration and misbranding of foods?

9. What are federal grade standards?

10. What are the complex relationships existing among individual consumers, business, industry, and governmental entities?

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Food Science and Technology

PROBLEM AREA: Adhering to Government Regulations

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES

1. Using an interest approach, introduce the problem area and discuss what is to be studied.
2. Conduct a discussion and define the Product Development and Quality Control Departments of a food science firm.
3. Discuss the organizational structure of a food science business. Include a discussion as to where the Product Development and Quality Control Departments fit into the organization structure.
4. Explain to the class the types of activities and functions of a Quality Control Department.
5. Discuss examples of routine quality control procedures of a food science firm.
6. Have a guest speaker from a food science firm or from a university talk with the class about Research and Product Development and Quality Control.
7. Explain the federal government agencies and their regulating responsibilities related to food processing.
8. Have students complete Student Worksheet #1.
9. Have students complete Student Worksheet #2.
10. Discuss the rules and regulations that the FDA uses to administer food laws.
11. Discuss adulteration and misbranding of foods.
12. Have students conduct a library search and research a historical instance of food adulteration, large-scale poisoning from food, etc. Students will develop a research paper on this event.
13. Discuss Federal Grade Standards of Foods.
14. Have students search and collect Federal Grade Standard Marks or Stamps from foods at home. Have students create posters which include these stamps or marks and label what foods they came from.
15. Have a state or federal meat inspector visit the class as a guest speaker. Have the inspector discuss different meat grades and his or her job duties.
16. Conduct a class project that includes mapping an organizational structure showing the extensive relationships among individual consumers, business, industry, and government. The relationships demonstrated should be in the area of food regulation.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Food Science and Technology

PROBLEM AREA: Adhering to Government Regulations

REFERENCES

*1. *Introduction to Food Processing*. (1985). Jelen, Pavel. Reston Publishing Company, Inc., A Prentice-Hall Company, Reston, VA 22090.

*2. *Food Science*. (1986). Potter, Norman N. 4th edition. The AVI Publishing Company, Inc., c/o Van Nostrand Reinhold, 115 Fifth Avenue, New York, NY 10003.

*3. *Food Science and Nutritional Health: An Introduction*. (1984). Labuza, T.P., Erdman, J.W., Jr. West Publishing Co., 50 West Kellogg Boulevard, P.O. Box 43526, St. Paul, MN 55164.

*Indicates highly recommended reference

INSTRUCTOR'S NOTES AND REFERENCES

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INSTRUCTIONAL RESOURCES

These resources are intended for use by teachers in planning and teaching the materials for this problem area and may be adapted to fit the teaching method(s) used.

INFORMATION SHEET #1 — Rules and Regulations of the Food and Drug Administration (FDA)

INFORMATION SHEET #2 — Adulteration and Misbranding of Foods

INFORMATION SHEET #3 — Federal Grade Standards

INFORMATION SHEET #4 — Relative Importance of Factors Involved in USDA Standards for Processed Fruit and Vegetable Products

TRANSPARENCY MASTER #1 — Function of Product Development and Quality Control Departments

TRANSPARENCY MASTER #2 — Simplified Organizational Chart of a Food Company

TRANSPARENCY MASTER #3 — Functions of a Quality Control Department

TRANSPARENCY MASTER #4 — Quality Control Functions

TRANSPARENCY MASTER #5 — Quality Control Procedures

TRANSPARENCY MASTER #6 — Rules and Regulations of the Food and Drug Administration (FDA)

TRANSPARENCY MASTER #7 — Some Federal Grade Marks for Beef

TRANSPARENCY MASTER #8 — Changes in Interior Quality of Eggs on Aging, and The Defect of Puffiness in Tomatoes

INFORMATION SHEET #1

Rules and Regulations of the Food and Drug Administration (FDA)

The following is a list of rules and regulations which the FDA uses to administer various food laws.

1. Filth action levels define the amounts of natural filth allowed in foods marketed in interstate commerce.

2. Pesticide action levels and tolerances define the amounts of pesticides allowed in foods. A pesticide content in excess of these levels can result in FDA seizure of the food.

3. Poisonous and deleterious substance action levels and tolerances are similar to those for pesticides. Some levels have been set for mecury, PCBs, and alflatoxin.

4. Standards of identity regulations define a standardized food product in terms of how it can be made and/or what ingredients must be in it. These standards are for the promotion of honesty and fair dealing in the interest of consumers.

5. Labeling regulations define the type and size of package labels, and the specific information that must be printed on the label to prevent deception of the consumer.

6. Regulations to insure safe thermal process of food give the specifics in the process.

7. Good manufacturing practice regulations (GMP) define what methods the processor should use to insure that the food produced is safe and free of harmful or decay microorganisms.

8. Nutritional regulations were put into effect in 1975 after several years of discussion and changes. They define what can be said on the package about the product's nutritional value.

9. Recall procedures are guidelines that were developed to help a company retrieve, from the food distribution channel, foods that are in possible violation of the Food, Drug, and Cosmetic Act. FDA cannot force companies to remove the food; the action is voluntary. However, FDA can seize the food. FDA forces the recall by announcing a possible violation in the media.

   a. Class I Recall — A priority procedure in which full press coverage is given because consumption of the food is an imminent health hazard and could cause death.

   b. Class II Recall — A procedure that deals with low levels of mecury or pesticides present in food as well as filth above an action guideline. There is danger to health, but it is less serious.

   c. Class III Recall — A procedure that deals with economic fraud. A possible pathogen present in food can also constitute a Class III Recall if it is not a threat to health. Wide press coverage is not used for this category.

10. Common or usual name regulations provide that the producer must use a product name that accurately describes the product and that pictures of food on the package must not be made to look better than what is actually inside the package.

These regulations are not laws but the courts uphold them as such. The need for regulations exists because Congress usually only indicates general, not specific, guidelines when passing a law.

Many other rules and regulations have been published by FDA and will continue to be published. They're designed to help government carry out the basic requirements of the 1983 Food, Drug, and Cosmetic Act and any laws that pertain to food.

INFORMATION SHEET #2

Adulteration and Misbranding of Foods

1. Food Adulteration — Defined as the intentional or unintentional addition of any poisonous or deleterious indredient or substance to a food. Also applies to items that are not specifically intentional chemical additives. Examples of food adulteration include the following:

    a. *Clostridium botulinum* or any pathogen found growing in canned food.
    b. Contamination due to rat feces in food due to mishandling or poor sanitation.
    c. Additives over the maximum allowed amount.
    d. Levels of pesticides, aflatoxin, or heavy metals over allowable limits.
    e. Ingredients in excess of or below required level or amount listed on the package.
    f. Levels of filth in food above tolerance allowed.
    g. Use of diseased animals in food.
    h. Unsanitary practices in production.

    All of the above examples of adulteration are of sufficient threat to warrant the government's seeking a Class I Recall, or seizing and destroying the food and imposing penalities on the producer.

2. Misbranding — Regulations on label requirements were set up to control false labeling. Failure to reveal any facts that must be on a food label would constitute misbranding. Substitution is a violation (example would be substituting margarine for butter in a product). Under the regulations governing misbranding, a company cannot offer for sale an inferior product without declaring that it is below standard or is an imitation.

INFORMATION SHEET #3

Federal Grade Standards

The Federal Grade Standards are standards of quality administered by the USDA Agricultural Marketing Service and the Food Safety and Inspection Service. Uniform grades of quality have been established for over 100 foods, including meat, dairy, poultry, fruit, vegetable, and seafood products.

Meat products — Grading evaluates overall quality of beef, taking into account shape of animal carcass, quality and distribution of exterior fat, age of animal, firmness and texture of flesh, fat marbling, and color of lean meat.

Eggs — Grading evaluates freshness, measured by visual inspection of egg white and egg yolk. Fresh eggs have high percent of thick white next to yolk and a small amount of thin white beyond the thick white. Egg yolk flattens with aging and loss of freshness.

Tomatoes — Grading evaluates ripeness, color, freedom of cracks and blemishes, size, and limited "puffiness." This last attribute is the amount of air void or open space between the tomato wall and central pulp.

INFORMATION SHEET #4

Relative Importance of Factors Involved in USDA Standards for Processed Fruit and Vegetable Products

Product	Absence of Defects	Color	Flavor	Character	Consistency	Uniformity	Texture	Tenderness and Maturity	Clearness of Liquor
Apples	20	20	—	40	—	20 siz.	—	—	—
Apple butter	20	20	20	20 fin.	20	—	—	—	—
Apple juice	20	20	60	—	—	—	—	—	—
Apple sauce	20	20	20	20 fin.	20	—	—	—	—
Apricots	30	20	—	30	—	20 siz.	—	—	—
Asparagus	30	20	—	—	—	—	—	40	10
Green & wax beans	35	15	—	—	—	—	—	40	10
Dried beans	40	—	—	40	20	—	—	—	—
Lima beans	25	35	—	30	—	—	—	—	10
Beets	30	25	—	—	—	15	30	—	—
Berries	30	20	—	30	—	20	—	—	—
Blueberries	40	20	—	40	—	—	—	—	—
Carrots	30	25	—	—	shape	15 siz.	30	—	—
Cherries, sweet	30	30	—	20	—	20 siz.	—	—	—
Cherries, sour	30	20	—	30	—	20 pits	—	—	—
Corn, cream	20	10	20	—	20	—	—	30	—
Corn, whole	20	10	20	—	—	—	—	40	10
Cranberry sauce	20	20	20	—	40	—	—	—	—
Figs, kadota	30	20	—	35	—	15 siz.	—	—	—
Frozen apples	20	20	—	40	—	20	—	—	—
Fruit cocktail	20	20	—	20	—	20	—	—	20
Fruit jelly	—	20	40	—	40	—	—	—	—
Fruit preserv. (Jam)	20	20	40	—	20	—	—	—	—
Fruit salad	30	20	—	30	—	20 siz.	—	—	—
Grapefruit	20	20	—	20		(Wholeness 20)(Drained Wt. 20)			
Grapefruit juice	40	20	40	—	—	—	—	—	—
Grape juice	20	40	40	—	—	—	—	—	—
Lemon juice	35	35	30	—	—	—	—	—	—
Mushroom	30	30	—	20	—	20 siz.	—	—	—
Olives, green	30	30	—	20	—	20 siz.	—	—	—
Olives, ripe	10	15	30	25	—	20	—	—	—
Orange juice	20	40	40	—	—	—	—	—	—
Orange juice con.	20	40	40	—	—	—	—	—	—
Orange marm.	20	20	40	—	20	—	—	—	—
Okra	20	15	15	—	—	10	—	35	5
Peaches	30	20	—	30	—	20 siz.	—	—	—
Peanut butter	30	20	30	—	20	—	—	—	—
Pears	30	20	—	30	—	20 siz.	—	—	—
Peas	30	10	—	—	—	—	—	50	10
Peas, field	40	20	—	40	—	—	—	—	—
Cucumber pick.	30	20	—	—	—	20	30	—	—
Pimientos	40	30	—	10	—	20 siz.	—	—	—
Pineapples	30	20	—	30	—	20	—	—	—
Pineapple juice	40	20	40	—	—	—	—	—	—
Plums	30	20	—	30	—	20 siz.	—	—	—
Potatoes, peeled	40	20	—	—	—	20	20	—	—
Prunes, dried	30	20	—	35	—	15	—	—	—
Pumpkins & squash	30	20	—	20 fin.	30	—	—	—	—
Raspberries	20	25	—	35	—	20 siz.	—	—	—

Product	Absence of Defects	Color	Flavor	Character	Consistency	Uniformity	Texture	Tenderness and Maturity	Clearness of Liquor
Sauerkraut	10	15	45	15 crisp	—	—	—	—	15
Sauerkraut, bulk	10	15	45	15 crisp	—	—	—	—	15
Spinach	40	30	—	30	—	—	—	—	—
Sweet potatoes	40	20	—	20	—	20 siz.	—	—	—
Tomatoes	30	30	—	—		(Wholeness 20)	(Drained Wt. 20)		
Tomato juice	15	30	40	—	15	—	—	—	—
Tomato paste	40	60	—	—	—	—	—	—	—
Tomato pulp — pure	50	50	—	—	—	—	—	—	—
Tom. sauce — catsup	25	25	25	—	25	—	—	—	—
Chili sauce	20	20	20	20	20	—	—	—	—

Taken from *Food Science*. Potter. (1986). Van Rostrand Reinhold, 115 Fifth Ave., New York, NY 10003.

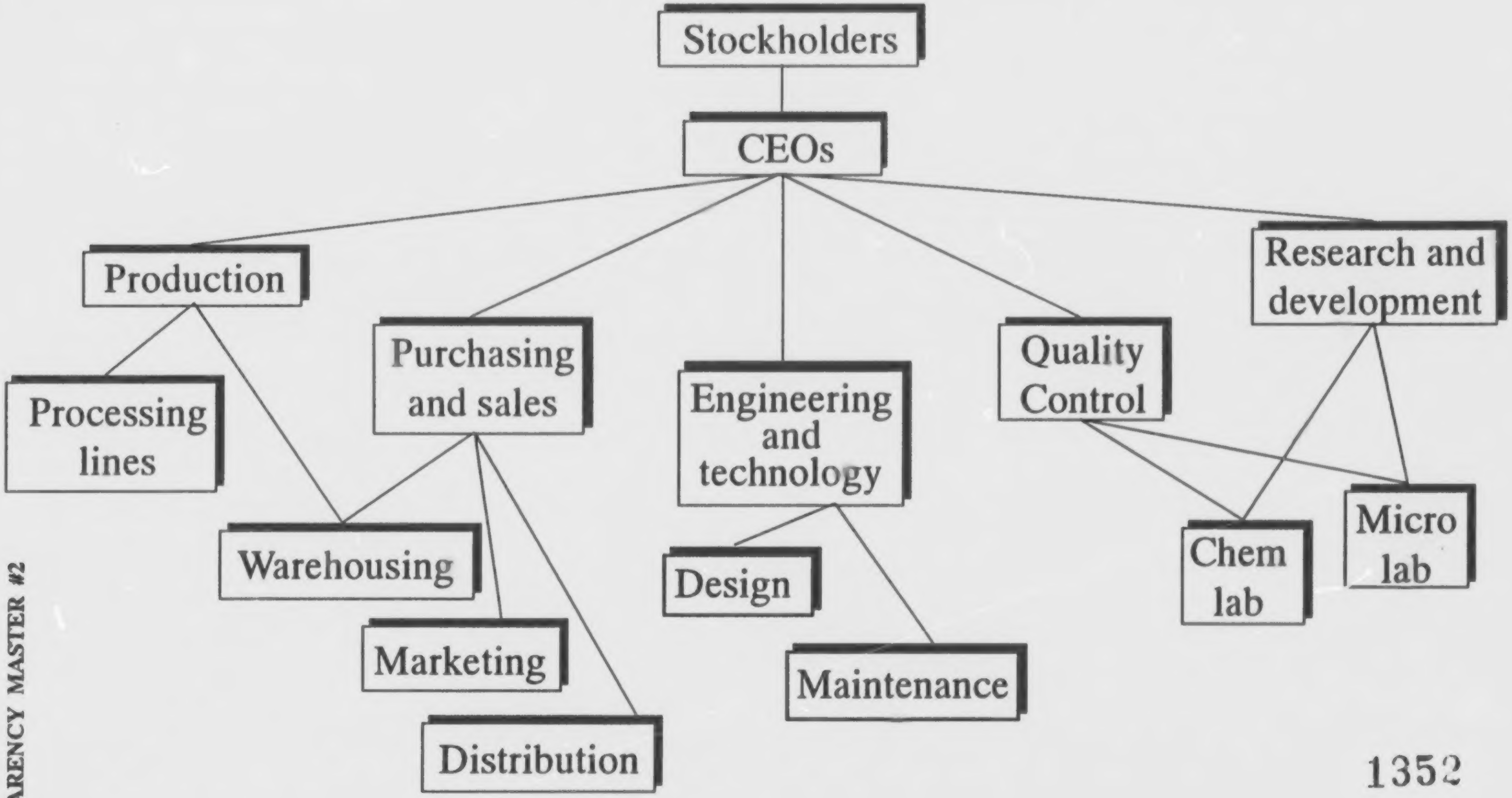
TRANSPARENCY MASTER #1

Function of Product Development and Quality Control Departments

Product Development (or Research and Development) — Efforts are aimed at new, nonexisting, or improved products or processes, methodologies, or laboratory procedures. Innovative approaches and nonroutine, independent experimentaion are often required. Basic research in biochemistry, microbiology, enzymology, chemistry, or engineering may be needed for development of new foods or new processes.

Quality Control (or Quality Assurance) — A standard routine is methodically followed, because quality assurance is concerned with existing products and processes. The required parameters of incoming raw materials and finished food products are continuously monitored. Compliance with compositional standards of identity of various manufactured products is ensured, as well as compliance with various governmental regulations dealing with the use of additives. In microbiological laboratories, monitoring of microbial content of ingredients and final products is carried out.

Simplified Organizational Chart of a Food Company



Stockholders

CEOs

Production

Processing lines

Warehousing

Purchasing and sales

Marketing

Distribution

Engineering and technology

Design

Maintenance

Quality Control

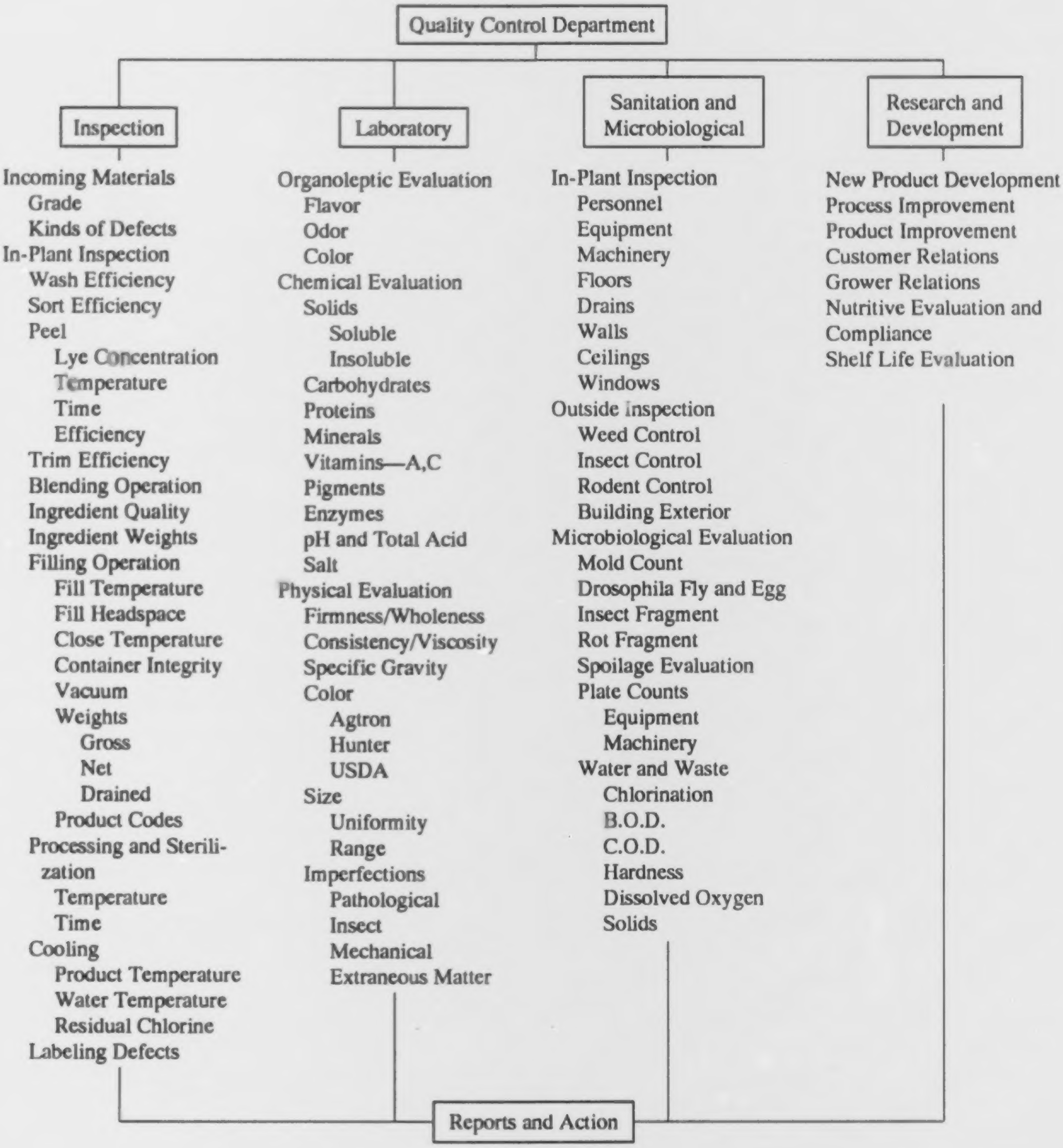
Research and development

Chem lab

Micro lab

TRANSPARENCY MASTER #3

Functions of a Quality Control Department



Quality Control Department

Inspection

- Incoming Materials
  - Grade
  - Kinds of Defects
- In-Plant Inspection
  - Wash Efficiency
  - Sort Efficiency
  - Peel
    - Lye Concentration
    - Temperature
    - Time
    - Efficiency
  - Trim Efficiency
  - Blending Operation
  - Ingredient Quality
  - Ingredient Weights
  - Filling Operation
    - Fill Temperature
    - Fill Headspace
    - Close Temperature
    - Container Integrity
    - Vacuum
    - Weights
      - Gross
      - Net
      - Drained
    - Product Codes
  - Processing and Sterilization
    - Temperature
    - Time
  - Cooling
    - Product Temperature
    - Water Temperature
    - Residual Chlorine
  - Labeling Defects

Laboratory

- Organoleptic Evaluation
  - Flavor
  - Odor
  - Color
- Chemical Evaluation
  - Solids
    - Soluble
    - Insoluble
  - Carbohydrates
  - Proteins
  - Minerals
  - Vitamins—A,C
  - Pigments
  - Enzymes
  - pH and Total Acid
  - Salt
- Physical Evaluation
  - Firmness/Wholeness
  - Consistency/Viscosity
  - Specific Gravity
  - Color
    - Agtron
    - Hunter
    - USDA
  - Size
    - Uniformity
    - Range
  - Imperfections
    - Pathological
    - Insect
    - Mechanical
    - Extraneous Matter

Sanitation and Microbiological

- In-Plant Inspection
  - Personnel
  - Equipment
  - Machinery
  - Floors
  - Drains
  - Walls
  - Ceilings
  - Windows
- Outside Inspection
  - Weed Control
  - Insect Control
  - Rodent Control
  - Building Exterior
- Microbiological Evaluation
  - Mold Count
  - Drosophila Fly and Egg
  - Insect Fragment
  - Rot Fragment
  - Spoilage Evaluation
  - Plate Counts
    - Equipment
    - Machinery
  - Water and Waste
    - Chlorination
    - B.O.D.
    - C.O.D.
    - Hardness
    - Dissolved Oxygen
    - Solids

Research and Development

- New Product Development
- Process Improvement
- Product Improvement
- Customer Relations
- Grower Relations
- Nutritive Evaluation and Compliance
- Shelf Life Evaluation

Reports and Action

Taken from *Food Science*. Potter. (1986). Van Rostrand Reinhold, 115 Fifth Ave., New York, NY 10003.

TRANSPARENCY MASTER #4

Quality Control Functions

Type of Activity	*Example*
1. Records and Reporting	Develop the mechanisms and forms necessary for maintenance of quality control records for use in responding to legal requirements and consumer complaints.
2. Sampling Schedules	Designate a schedule of sampling that requires the minimum amount of work while maximizing the detection of non-compliance to standards.
3. Special Problems	Personnel trainings, short course work, consumer complaints, bad product lots and associated production problems.
4. Compliance with Specifications	Meet compliance standards set by company policy; set by buyer specifications; set by shelf life needs; and set by applicable law.
5. Test Procedures	Develop criteria and perform tests on raw materials, processes, and end products.
6. Troubleshooting	Investigate and resolve problems associated with processing supplies such as poor quality materials, erratic supplies, and malfunctioning machines, as well as non-standard final products.

TRANSPARENCY MASTER #5

Quality Control Procedures

Category of Tests	*Purpose and Example*
Chemical	Waste discharge analyses Antibiotic presence analyses (e.g., raw milk) Nutrient presence analyses (e.g., calcium, vitamins) Raw material and finished product analyses (i.e. fat, moisture, protein)
Microbiological	Culture testing (e.g., fermented products) Efficiency of procedures for cleaning (e.g., swab testing of equipment) Uncovering microbiological problems in processing lines Running raw material and finished product plate counts (e.g., coliforms, yeasts and molds, and tranquilizers)
Sensory	Conducting taste tests between competitor products and own products Grading products by sensory tests (e.g., butter and cheese) Periodic routine testing of own products for quality maintenance Testing by instruments for aroma, color, and texture
Other	Finished product shelf life testing by acceleration means Retail store display cabinet testing by random control of temperature in cabinets

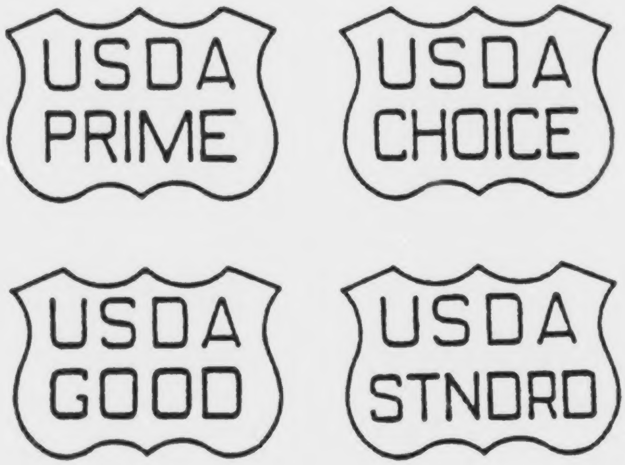
TRANSPARENCY MASTER #6

Rules and Regulations of the Food and Drug Administration (FDA)

1. Filth Action Levels
2. Pesticide Action Levels and Tolerances for Foods
3. Poisonous and Deleterious Substance Action Levels and Tolerances
4. Standards of Identity Regulations
5. Labeling Regulations
6. Regulations for Safe Thermal Process of Food
7. Good Manufacturing Practice Regulations (GMP)
8. Nutritional Regulations
9. Recall Procedures
    a. Class I Recall
    b. Class II Recall
    c. Class III Recall
10. Common or Usual Name Regulations

TRANSPARENCY MASTER #7

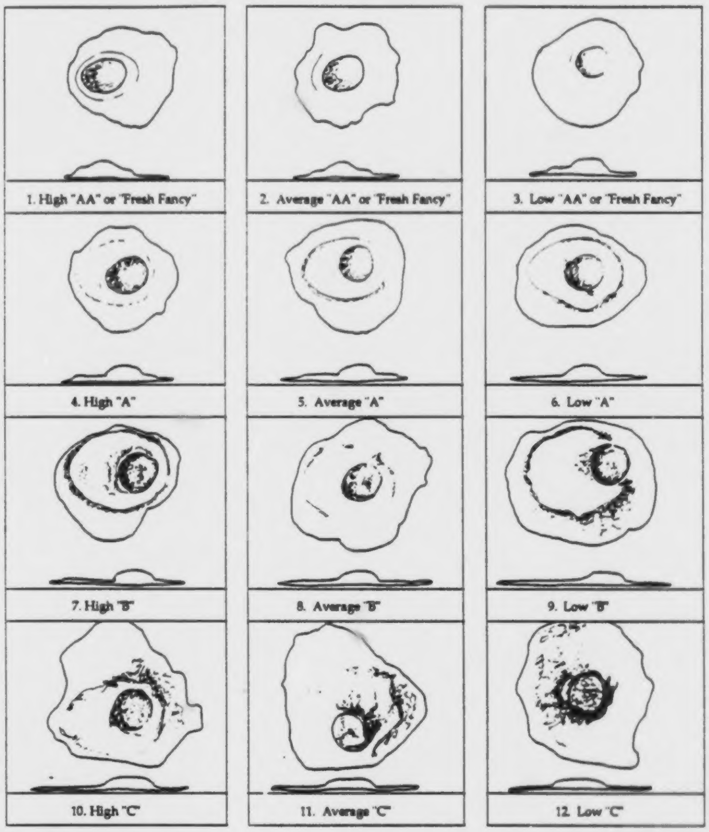
Some Federal Grade Marks for Beef


USDA PRIME
USDA CHOICE
USDA GOOD
USDA STNDRD

Courtesy of U.S. Dept. of Agriculture

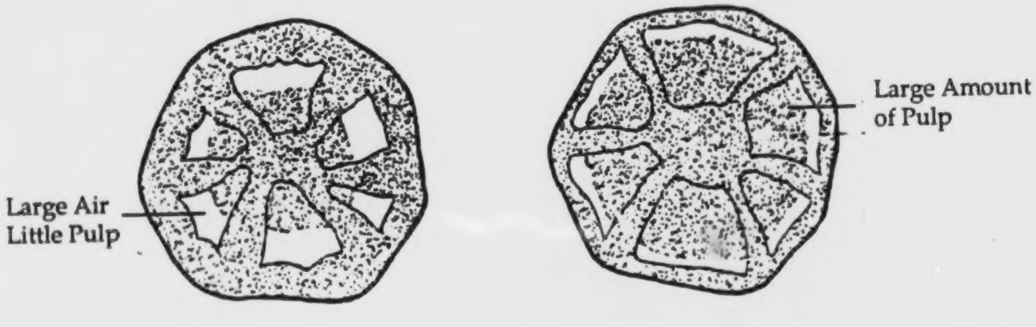
TRANSPARENCY MASTER #10

Changes in Interior Quality of Eggs on Aging


1. High "AA" or "Fresh Fancy"
2. Average "AA" or "Fresh Fancy"
3. Low "AA" or "Fresh Fancy"
4. High "A"
5. Average "A"
6. Low "A"
7. High "B"
8. Average "B"
9. Low "B"
10. High "C"
11. Average "C"
12. Low "C"

Courtesy of U.S. Dept. of Agriculture

The Defect of Puffiness in Tomatoes


Large Air
Little Pulp
Large Amount
of Pulp

Courtesy of U.S. Dept. of Agriculture

STUDENT ACTIVITIES

STUDENT WORKSHEET #1 — Federal Government Agencies and Their Regulatory Responsibilities Related to the Food Industry

STUDENT WORKSHEET #2 — Government Regulations Word Search (with solution)

For additional activities, teachers may refer to the "Suggested Teaching Activities and Procedures" section in the Instructor's Guide.

STUDENT WORKSHEET #1

Federal Government Agencies and Their Regulatory Responsibilities Related to the Food Industry

Match the federal government agency with its correct regulatory responsibilities related to the food industry.

1. ______ Department of Agriculture (USDA)
2. ______ Environmental Protection Agency (EPA)
3. ______ Department of Commerce (National Marines and Fisheries Bureau)
4. ______ Department of Commerce and Dept. of Agriculture (USDA)
5. ______ Department of Health and Human Services (USPHS and FDA)
6. ______ Federal Trade Commission (FTC)
7. ______ Department of Treasury (BATF)

A. Regulatory powers of international food trade.

B. Production and sales of all alcoholic beverages.

C. Regulation of catch, imports, and processing of fish products.

D. Control and enforcement of food processes resulting in pollution of waters, land, or air; control of pesticide application; control of water supplies.

E. Enforcement of all food legislation related to packaging, labeling, and advertising of food products.

F. Enforcement of standards of identity, plant sanitation inspection, veterinary inspection of meat, grading of meat, dairy, fruit and vegetable products.

G. Enforcement of food legislation regarding food wholesomeness and aspects concerning human health and food process sanitation; food served by transportation companies; advisory capacity in milk, food, and shell-fish sanitation.

STUDENT WORKSHEET #1 — Key

Federal Government Agencies and Their Regulatory Responsibilities Related to the Food Industry

Match the federal government agency with its correct regulatory responsibilities related to the food industry.

1. *F* Department of Agriculture (USDA)
2. *D* Environmental Protection Agency (EPA)
3. *C* Department of Commerce (National Marines and Fisheries Bureau)
4. *A* Department of Commerce and Dept. of Agriculture (USDA)
5. *G* Department of Health and Human Services (USPHS and FDA)
6. *E* Federal Trade Commission (FTC)
7. *B* Department of Treasury (BATF)

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STUDENT WORKSHEET #2

Government Regulations Word Search

M	I	Q	B	B	S	N	O	I	T	C	N	U	F	P	D	X	N	J	Q
H	E	N	C	S	T	A	N	D	A	R	D	S	N	X	G	K	G	X	R
W	Y	D	Y	N	V	U	L	E	E	S	W	G	X	E	N	G	K	N	P
Z	E	E	X	R	J	L	F	G	O	N	L	P	H	B	R	W	B	U	D
I	B	V	Y	B	U	G	U	Q	O	O	Z	F	T	A	J	B	P	R	K
S	T	E	H	R	M	T	U	Y	R	V	W	Y	D	E	G	S	C	Q	B
V	T	L	O	Z	O	F	Y	T	R	Y	E	E	M	N	A	T	S	R	B
X	R	O	Z	R	V	T	N	M	W	T	C	R	I	O	S	Y	N	M	Q
Q	J	P	E	R	G	O	A	M	I	O	S	R	N	N	L	Q	N	U	R
F	G	M	E	Y	C	A	Q	R	V	C	E	I	O	M	H	O	A	E	S
L	C	E	C	V	R	M	N	H	O	E	R	I	M	C	E	L	G	T	B
S	Q	N	X	F	O	T	M	I	N	B	T	O	R	E	I	N	C	Y	Y
R	M	T	K	N	C	O	S	I	Z	A	A	A	B	T	H	U	T	W	J
E	X	M	I	T	K	E	G	I	L	A	E	L	Y	I	D	C	R	Y	Q
H	F	T	X	W	U	N	N	U	M	S	T	V	R	O	O	O	O	R	Z
G	O	M	K	Q	E	X	G	U	E	E	X	I	R	A	U	L	K	I	P
R	W	J	B	U	D	E	J	R	Y	X	H	P	O	T	N	Y	O	F	B
I	R	M	T	I	R	G	H	W	R	M	B	C	I	N	L	L	U	G	W
K	X	G	U	I	D	E	L	I	N	E	S	N	R	G	Z	A	E	U	Y
V	Q	A	J	Y	O	M	O	D	J	I	E	G	I	U	A	N	U	D	E

The following words are hidden in the puzzle:

Biochemistry
Chemistry
Control
Development
Engineering
Enzymology
Functions
Government
Grade
Guidelines

Laboratory
Microbiology
Monitor
Organization
Products
Quality
Regulations
Research
Routine
Standards

1362

STUDENT WORKSHEET #2 — Key

Government Regulations Word Search

•	•	•	•	•	S	N	O	I	T	C	N	U	F	•	•	•	•	•	•
•	•	•	•	S	T	A	N	D	A	R	D	S	•	•	•	•	•	•	•
•	•	D	•	•	•	•	•	•	E	•	•	•	•	•	•	G	•	•	•
•	•	E	•	•	•	•	•	G	•	N	L	•	•	•	R	•	•	•	•
•	•	V	Y	•	•	•	•	•	O	O	Z	•	•	A	•	•	•	•	•
•	•	E	•	R	•	•	•	Y	R	V	•	Y	D	•	G	•	•	•	•
•	•	L	O	•	O	•	•	T	R	•	E	E	M	N	•	•	•	•	•
•	•	O	•	R	•	T	N	M	•	T	•	R	I	O	S	•	•	•	•
•	•	P	•	•	G	O	A	•	I	•	S	R	N	N	L	•	•	U	•
•	•	M	•	Y	C	A	•	R	•	C	E	I	O	M	H	O	A	•	S
•	•	E	•	•	R	M	N	•	O	E	R	I	M	C	E	L	G	T	•
•	•	N	•	•	O	T	•	I	N	B	T	O	R	E	I	N	C	Y	•
•	•	T	•	N	•	•	S	I	Z	A	A	A	B	T	H	U	T	•	•
•	•	•	I	•	•	•	G	I	L	A	E	L	Y	I	D	C	R	•	•
•	•	T	•	•	•	N	•	U	M	S	T	•	•	O	O	O	O	•	•
•	O	•	•	•	E	•	G	•	E	E	•	I	R	•	U	L	•	I	•
R	•	•	•	•	•	E	•	R	•	•	H	P	O	T	•	•	O	•	B
•	•	•	•	•	R	•	•	•	•	•	•	C	I	N	•	•	•	G	•
•	•	G	U	I	D	E	L	I	N	E	S	N	•	•	•	•	•	•	Y
•	•	•	•	•	•	•	•	•	•	•	E	•	•	•	•	•	•	•	•

The following words are hidden in the puzzle:

Biochemistry
Chemistry
Control
Development
Engineering
Enzymology
Functions
Government
Grade
Guidelines

1363

Laboratory
Microbiology
Monitor
Organization
Products
Quality
Regulations
Research
Routine
Standards

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Food Science and Technology

PROBLEM AREA: Meeting Nutritional Needs of Food Consumers

RELATED PROBLEM AREAS:

1. Understanding Food Science Technology (Central Core Cluster)
2. Processing Agricultural Products
3. Adhering to Government Regulations
4. Packaging and Distributing Food Products

PREREQUISITE PROBLEM AREA(S):

1. Understanding Food Science Technology (Central Core Cluster)

LEVEL: Preparatory

OCCUPATIONAL TASKS ADDRESSED: None

STATE GOALS FOR LEARNING:

In planning the instruction for this problem area, teachers can promote the development of several student learning objectives which are related to the State Goals for Learning in Biological and Physical Sciences. These objectives are listed on the Learning Assessment Plan forms included on the following page(s). Those learning objectives marked with an asterisk (*) are taken from the sample lists provided by the Illinois State Board of Education.

CORE

Illinois Agricultural Core Curriculum

Agricultural Education 124 Mumford Hall 1301 W. Gregory Drive University of Illinois Urbana, IL 61801

Director: Dale A. Law, Ed.D.
Principal Investigator: Jerry D. Pepple, Ed.D.
Research Assistant: Randy J. Bernhardt

1365

Illinois Agricultural Core Curriculum Rev.

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date ____________________
☐ Original submission ☐ Revision
Page _____ of _____

(Affix label or complete district information.)

COUNTY	DISTRICT	ESC

District Name

City

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☒ Sciences ☐ Physical Development/Health

II. STATE GOAL FOR LEARNING
As a result of their schooling, students will have a working knowledge of the concepts and basic vocabulary of biological, physical, and environmental sciences and their application to life and work in contemporary technological society.

Contact Person: ____________________
Title: ____________________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
1. Understand the role of food and energy and the role of proteins, carbohydrates, and fats.					
2. Understand macronutrients and micronutrients.					
3. Develop a knowledge of the nutritional needs of the human body.					
4. Understand the nutritive value of processed foods.					
5. Understand the composition of food.					
6. Determine if today's American diet is adequate.					
*7. Understand the use of nutrients in the body.					
1366					1367

ISBE 41-78 (1/88)

Agricultural Business and Management
Food Science and Technology

Meeting Nutritional Needs of Food Consumers

Submission Date ____________
☐ Original submission ☐ Revision
Page _____ of _____

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☒ Sciences ☐ Physical Development/Health

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)

COUNTY	DISTRICT	ESC

District Name
City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will have a working knowledge of the social and environmental implications and limitations of technological development.

Contact Person: ____________
Title: ____________
Phone: ( )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
1. Develop an understanding of the use of additives in food.					
*2. Evaluate the need for additives in products used in the home.					
3. Understand the changes in certain food products through the application of food science.					
1368					
					1369

ISBE 41-78 (1/88)

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date ____________________
☐ Original submission ☐ Revision
Page ____ of ____

(Affix label or complete district information.)

COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐

District Name

City

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☒ Sciences ☐ Physical Development/Health

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will have a working knowledge of the principles of scientific research and their application in simple research projects.

Contact Person: ____________________
Title: ____________________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Apply scientific knowledge through the proper use of techniques, laboratory instruments, and the unbiased reporting of results.					
2. Conduct food science experiments, in one of which laboratory animals are used.					

ISBE 41-78 (1/88)

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Food Science and Technology

PROBLEM AREA: Meeting Nutritional Needs of Food Consumers

STUDENT LEARNING OBJECTIVES

Upon completion of their study of this problem area, students will be able to:

1. Understand the role of food and energy and the role of proteins, carbohydrates, and fats.
2. Understand macronutrients and micronutrients.
3. Develop a knowledge of the nutritional needs of the human body.
4. Understand the nutritive value of processed foods.
5. Understand the composition of food.
6. Determine if today's American diet is adequate.
7. Evaluate the need for additives in products used in the home.
8. Understand the changes in certain food products through the application of food science.
9. Conduct food science experiments, in one of which laboratory animals are used.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Food Science and Technology

PROBLEM AREA: Meeting Nutritional Needs of Food Consumers

PROBLEMS AND QUESTIONS FOR STUDY	INSTRUCTOR'S NOTES AND REFERENCES

1. What is the role of food and energy?
2. What are proteins?
3. What are carbohydrates?
4. What are fats?
5. What is the role of proteins, carbohydrates, and fats in human nutrition?
6. What are macronutrients?
7. What are micronutrients?
8. What are the nutritional needs of the human body?
9. What is the nutritional value of processed foods?
10. What is the composition of food?
11. Is today's American diet adequate?
12. Can you explain the use of nutrients in the body?
13. What is a food additive?
14. Why are additives put in food?
15. What changes have evolved with food?
16. Can you conduct a laboratory experiment?
17. Can you conduct a six-week laboratory experiment on the effect of diets of various nutritional characteristics on weight gain in laboratory rats?

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Food Science and Technology

PROBLEM AREA: Meeting Nutritional Needs of Food Consumers

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES

1. Discuss with the students the general principles of the unit. Use an interest approach to begin the unit.
2. Conduct a class discussion on the topic, "Food and Energy."
3. Ask students, "What are carbohydrates, proteins, and fats? What are their role in human nutrition?" Conduct a discussion on carbohydrates, proteins, and fats.
4. Have students make a poster showing complete protein foods and incomplete protein foods.
5. Have students complete Student Worksheet #1.
6. Have students complete Student Worksheet #2.
7. Have students conduct a comparison between the protein content, calorie content, and cost per serving of a meat, chicken, eggs, and a complementary food such as macaroni and cheese.
8. Discuss the difference between macronutrients and micronutrients. Explain vitamins and nutrients and their role in human nutrition.
9. Conduct a class discussion on the nutritional requirements of the human body.
10. Conduct a laboratory experiment on the effects of fat consumption on weight gain. Refer to Student Worksheet #3.
11. Ask students, "Which is better for you nutritionally, fresh or processed foods?" Use this question to lead into a discussion on the nutritional value of processed foods.
12. Discuss with the class the composition of food and explain the term "proximate composition."
13. Have students conduct an animal nutrition laboratory experiment. Refer to Student Worksheet #4.
14. As supervised study, have students read pages 152-162 in *Food Science and Nutritional Health: An Introduction* (see references). You can also use any other book that discusses the adequacies and inadequacies of the American diet.
15. Have students calculate nutritional content of their favorite fast food meal. Is this meal nutritionally adequate?
16. Have students complete Student Worksheet #5.
17. Conduct a classroom discussion on food additives.
18. Have students complete Student Worksheet #6.
19. Have students complete Student Worksheet #7.
20. Have students bring to class ingredient labels from food products at home. Students should determine which ingredients are food additives.
21. Ask students, "What changes have you seen in the preparation or presentation of food products?" Use this question to lead into a discussion of those changes.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Food Science and Technology

PROBLEM AREA: Meeting Nutritional Needs of Food Consumers

REFERENCES

1. *Food for Today*. (1986). Kowtaluk, H., Kopan, A.O. 3rd Edition. Glencoe Publishing Company, 17337 Ventura Boulevard, Encino, CA 91316.

2. *Introduction to Food Processing*. (1985). Jelen, Pavel. Reston Publishing Company, Inc., A Prentice-Hall Company, Reston, VA 22090.

*3. *Food Science*. (1986). Potter, Norman N. 4th Edition. The AVI Publishing Company, Inc., Reinhold, 115 Fifth Avenue, New York NY 10003.

4. *Food Science and Nutritional Health: An Introduction*. (1984). Labuza, T.P., Erdman Jr., J.W. West Publishing Co., 50 West Kellogg Boulevard, P.O. Box 43526, St. Paul, MN 55164.

*5. *The Science Workbook of Student Research Projects in Food - Agriculture - Natural Resources*. (1985). College of Agriculture, The Ohio State University, 2120 Fyffe Road, Columbus, OH 43210. (614) 422-1734.

*Indicates highly recommended reference

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTIONAL RESOURCES

These resources are intended for use by teachers in planning and teaching the materials for this problem area and may be adapted to fit the teaching method(s) used.

INFORMATION SHEET #1 — Food and Energy

INFORMATION SHEET #2 — Carbohydrates, Fats, and Proteins

INFORMATION SHEET #3 — Macronutrients and Micronutrients

INFORMATION SHEET #4 — Nutritional Requirements of the Human Body

INFORMATION SHEET #5 — Nutritional Value of Processed Foods

INFORMATION SHEET #6 — Composition of Food

INFORMATION SHEET #7 — Food Additives and Why They are Used

INFORMATION SHEET #8 — Changes in Food Products

INFORMATION SHEET #9 — Care and Use of Laboratory Animals

INFORMATION SHEET #10 — Vegetarians Eat More Than Vegetables

TRANSPARENCY MASTER #1 — Fat-Soluble Vitamins, and Water-Soluble Vitamins

TRANSPARENCY MASTER #2 — Major Nutritional Deficiency Diseases and Their Causes

TRANSPARENCY MASTER #3 — Energy Content of Food Components and Some Common Foods

TRANSPARENCY MASTER #4 — Approximate Energy Needed by Healthy Adults for Common Activities

TRANSPARENCY MASTER #5 — Schematic Illustration of Structure of a Protein Molecule

TRANSPARENCY MASTER #6 — Amino Acids Essential for Humans

TRANSPARENCY MASTER #7 — Nutritional Quality of Some Common Food Proteins

TRANSPARENCY MASTER #8 — Examples of Important Dietary Minerals and Their Main Functions in the Human Body

TRANSPARENCY MASTER #9 — Approximate Micronutrient Content of Selected Food Items

TRANSPARENCY MASTER #10 — Proximate Composition of Some Raw Food Materials (Orientation Values)

TRANSPARENCY MASTER #11 — Proximate Composition of Some Processed Foods (Orientation Values)

TRANSPARENCY MASTER #12 — Food Additives

INFORMATION SHEET #1

Food and Energy

Food consumed provides the substance for building and maintaining the body, and the energy for all of the body's functions.

Food scientists consider the nutritive aspects of food from two points of view: (1) what nutrients the foods contain and the requirements of the human body for those nutrients; and (2) the relative stability of those nutrients and the effects of food processing and handling upon them.

The major sources of energy for the human body are carbohydrates, fats, and proteins. Their conversions to energy are of importance. The energy value of foods is measured in heat units called calories.

A calorie is the amount of heat required to raise one gram of water by one degree Celsius.

Different sources of carbohydrates, proteins, and fats yield different amounts of energy (calories).

Appropriate caloric consumption, dependent upon the age and energy level of the consumer, is important. While so many of the world's people go hungry, in the United States and certain other countries, obesity from excess caloric intake is a major nutritional disease.

INFORMATION SHEET #2

Carbohydrates, Fats, and Proteins

Carbohydrates

Carbohydrates are made up of the elements carbon, hydrogen, and oxygen. There are simple carbohydrates (sugar) and complex carbohydrates (starches). Carbohydrates occur mostly in plants. Milk and milk products contain one type of sugar. Foods naturally high in starches and sugars include:

- Fruits
- Vegetables, especially peas, beans, and potatoes
- Grains such as wheat, rice, oats, and corn.

Natural carbohydrates also help digestion because they contain fiber. The fiber, which is not digestible, supplies the bulk that helps food move through the intestines more easily.

Natural carbohydrates are relatively low in calories. Refined or processed carbohydrates are often added in large amounts to foods such as candy, cakes, pies, and nondiet soft drinks. The number of calories is high compared to amount of nutrients in these foods.

Carbohydrates should make up about fifty-five percent of a person's daily caloric intake. Forty-five percent should be natural starches. Ten percent should be refined or processed carbohydrates.

Processed sugars include:

- Sucrose
- Fructose
- Glucose
- Lactose
- Maltose

Ingredients that contain more than one type of sugar include:

- Corn syrup
- Maple syrup
- Molasses

If more carbohydrates are consumed than needed, they are changed to fat and stored in the body. Over time, weight gain may result.

Remember, the body needs carbohydrates to stay healthy. The best sources of carbohydrates are natural ones such as fruits, vegetables, and grains.

Fats

Fats are oil substances in animal products and some plant foods. Fats include:

- Butter and margarine
- Oil
- Fat layers in meat

Fat is contained in many foods, including:

- Egg yolks
- Whole milk
- Walnuts

The body uses fats in food for several purposes:

1. As a source of essential fatty acids. Fats are made of fatty acids, some which are essential nutrients. The body can make all fatty acids needed except for linoleic acid. Linoleic acid is needed for growth and healthy skin. Corn, soybean, and safflower oils are the best sources of linoleic acid.

2. As a means of transporting certain vitamins throughout the body. Some vitamins are carried by fat instead of water. Without some fat, the body wouldn't be able to use these vitamins.

3. As a source of energy. Fats supply twice as much energy as carbohydrates and proteins.

Health professionals recommend that only about 30% of the calories in the average diet should come from fat. Eating too many sweets can make one gain weight. Excess carbohydrates and proteins also are converted to fats in the body.

Proteins

Proteins make up seventy-five percent of all solid matter in the body. New cells are required to replace ill or injured cells and, in children and young adults, are required for growth. These new cells are produced by protein. Proteins are also needed for the production of antibodies, which help the body fight diseases. Proteins help maintain the body's water balance. They help also to keep blood neutral, preventing it from becoming too acidic or too alkaline.

Proteins are made up of amino acids, chemical compounds consisting mainly of carbon, hydrogen, oxygen, and nitrogen. The amino acids link together in differing ways to form different proteins.

Approximately 20 amino acids have been identified in protein foods. Most of these can be made by the body from other amino acids. Eight, however, cannot be made in sufficient amounts. These are essential amino acids because they have to be supplied by food.

Foods with adequate amount of essential amino acids are called complete proteins and include the following:

- Eggs and poultry
- Fish
- Meat
- Dairy products

Plant proteins are less complete than animal proteins. No single plant has all essential amino acids in the correct amounts.

One can increase the protein quality of a diet by eating animal foods along with plant foods. A complete protein diet can be obtained by combining the right kinds of plant foods.

During certain times in life, the need for protein is higher than at other times. Pregnant and nursing women need extra protein. Infants, children, and teenagers need more protein for growth. People lacking protein lack energy and are more easily susceptible to infections and diseases. Recovery period from illnesses and wounds will be longer than normal. Infants and children having severe shortages of protein over an extended period of time exhibit stunted growth, low resistance to disease, and mental retardation.

INFORMATION SHEET #3

Macronutrients and Micronutrients

Food consists principally of three macronutrients, proteins, fats (lipids), and carbohydrates. Together with water, which could also be considered a macronutrient, these components may constitute more than 99% of food matter.

The micronutrients contain primarily vitamins and minerals. The micronutrients are present in raw agricultural materials in minute quantities. While most of the nutritionally important minerals are present in foods in simple elemental forms, the vitamins are complex organic compounds which cannot be synthesized by the human body but are needed for its many biological functions.

INFORMATION SHEET #4

Nutritional Requirements of the Human Body

The human body cannot synthesize complex organic substances from simple inorganic compounds and water coming from the soil or the air.

Food supplies nutrients that are required for three principal functions: to provide energy; to facilitate development and maintenance of bones, muscles, and organs; and to support biochemical reactions controlling behavior or the proper functioning of organs.

Contemporary nutrition science has identified approximately fifty substances that the body requires from food because it cannot synthesize them; these substances are called essential nutrients.

The principal sources of food energy are carbohydrates and fats.

Proteins and minerals are the main nutrients needed for maintenance and repair of the body.

To insure adequate intake of all needed nutrients, a diet should include a variety of foods, fresh as well as processed.

INFORMATION SHEET #5

Nutritional Value of Processed Foods

Most food processing operations, including home meal preparation, and also prolonged storage of unprocessed agricultural materials on the farm, in a warehouse, in a health food store, or in a home, will result in losses of certain micronutrients. The various food processing operations used by industry are usually a compromise between technological feasibility, economic feasibility or effectiveness, and minimum destruction of nutrients.

Processing operations affect food nutrients in two principal ways. First, macronutrients or micronutrients may be physically removed from the food. The second involves deactivating the biological functions of unstable vitamins by means of a deactivating agent such as heat, light, or oxygen used in the process or present in storage.

Many processes may affect only some nutrients while improving the digestibility or bioavailability of others.

Anyone eating a varied, adequate diet containing foods from the main four groups of fruits and vegetables, bread and cereals, meat and fish, and milk and milk products, should be more than adequately nourished.

INFORMATION SHEET #6

Composition of Food

From the chemist's point of view, all agricultural materials and foods made from them are composed of chemicals.

The principal building blocks of all plant materials are simple chemical compounds such as:

- Oxygen or carbon dioxide from the air
- Phosphorus, nitrogen, and potassium from the soil, or fertilizer used to improve the soil
- Water
- Other chemical elements or their simple combinations

These and similar chemical building blocks are used by all living organisms to synthesize much more complex chemicals like proteins, fats, sugars, or vitamins.

The bulk of food components are complex organic compounds built from only a few principal elements — carbon, oxygen, hydrogen, and nitrogen — bound in an almost infinite variety of chemical combinations.

Several other elements (especially calcium, phosphorus, iron, or sulphur) may also be involved in the complex chemical structures of these organic compounds.

There are only five major categories of distinctly different chemical compounds that all foods are made of: proteins, carbohydrates, fats, minerals (ash), and water. The breaking down of a food into these five kinds of components is called proximate analysis. Its composition in terms of these five components is called proximate composition. Although from a nutritional standpoint vitamins are classified as a separate nutrient group, in proximate analysis of foods they will be included with some of the principal proximate components.

Proximate composition is always given in weight percentages. The weight of all the five components present will add up to 100 percent.

Knowledge of proximate composition of raw materials as well as of processed foods is important for both the food processors and the consumers. The dairy processor, for example, must know how much fat there is in the milk that is going to be processed into butter.

Similarly, processors of grains, oilseeds, fruits and vegetables, meats, and other agricultural products must know the proximate composition of raw materials, especially when there are large differences in relative composition of the compounds among food products derived from different varieties or breeds, grown or raised using different production techniques, etc.

Proximate composition of finished food products is also of major interest to both processors and consumers. Many processed foods must conform to legal definitions which are usually given in terms of proximate composition.

In some European countries, proximate composition data must be displayed on most food products sold to the public. In view of current consumer concerns related to nutrition, a similar requirement for such simple nutritional information should be mandatory in the United States. Such a required display of proximate analysis data would provide much more meaningful information than the selectively applied voluntary program of today.

INFORMATION SHEET #7

Food Additives and Why They are Used

The FDA defines a food additive as "any substance, the intended use of which results or may reasonably be expected to result, directly or indirectly, in its becoming a component of or otherwise affecting the characteristics of any food (including any substance intended for use in producing, manufacturing, packing, processing , preparing, treating, transporting or holding a food; and including any source of radiation intended for any such use), if such substance is not generally recognized, among experts qualified by scientific training and experience to evaluate its safety, as having been adequately shown through scientific procedures to be safe under the conditions of its intended use."

Why Use Food Additives?

No highly developed society could exist today without food additives. Food additives immediately become necessary when areas of food production are separated from areas of population concentration with the result that food must be stored or transported under conditions that can affect spoilage. These food additives are preservative in nature.

A variety of chemicals added to foods are not primarily preservative, but are added for properties associated with food color, flavor, or texture. Others are added as nutritional supplements and as processing aids in manufacturing the thousands of products that consumers demand.

Many of the functions of food additives would not be needed if the majority of foods were prepared in the home from basic raw materials acquired and held without spoilage. This is not the case in the U.S. and in other advanced countries where most of what is eaten is consumed in the form of convenience foods.

Testing for Safety

Testing for safety of food additives can require several years depending upon the nature of the substance being evaluated. Most commonly, safety testing begins with the feeding of animals of two or more species using high levels of test material administered as a single dose orally or by injection into the bloodstream. This is known as an acute toxicity test and is intended to reveal the first indications of harmful effects.

Subacute toxicity testing usually follows acute toxicity testing. Here large numbers of animals are fed daily for 90 days at levels of the test material below the lethal dose. This determines the maximum level of the test material that is without adverse effect. It is also a method to further observe the nature of adverse effects at higher levels.

Chronic toxicity testing follows. This involves feeding the test material to experimental animals through their lifetime (in rats about 3 years). Daily feeding of many animals commonly includes levels 10 to about 100 times the human allowable levels calculated from subacute testing. Animals are sacrificed at intervals and examined physiologically and biochemically in great detail.

Many other tests of additives may follow as well. The three types given above are examples of the testing conducted with food additives.

Risks and Benefits of Additives

It is rational to accept some risk when the benefits are sufficiently great. Benefits involve economic savings. Banning of a low-risk additive can sometimes produce special hardships. Every reasonable effort must be made to minimize risk from our food supply, but in the final analysis zero risk is unattainable and its pursuit is very costly.

Classes of Food Additives

1. Preservatives — preserve against bacteria, yeasts, and molds.
2. Antioxidants — prevent oxidation of fat.
3. Sequestrants — combine with trace metals such as iron and copper and remove them from solution.
4. Surface active agents — used to stabilize oil-in-water and water-in-oil mixtures, gas-in-liquid mixtures, and gas-in-solid mixtures.
5. Stabilizers, thickeners — stabilize and thicken foods by combining with water to increase viscosity and to form gels; include gums, starches, dextrins, protein derivatives, and other additives.
6. Bleaching and maturing agents, starch modifiers — bleach the yellow color of milled flour; whiten the color of milk for certain cheese manufacturing.
7. Buffers, acids, alkalies — pH-adjusting and pH-controlling chemicals.
8. Food colors — added to thousands of food items to give consumers the appetizing and attractive qualities desired.
9. Nonnutritive and special dietary sweeteners — include saccharin, cyclamates (banned in 1969), and nutrasweet.
10. Nutrient supplements — added as supplements and enrichment mixtures to a number of food products; include vitamins and minerals.
11. Flavoring agents — used to flavor foods; natural flavorings include spices, herbs, essential oils, and plant extractives; synthetic (artificial) flavor additives are also used.

INFORMATION SHEET #8

Changes in Food Products

Why has public interest in nutrition intensified in recent years? Have foods become less nutritious? Has the food industry become less ethical?

In typical food markets of the early 1900s, foods were easily recognizable, and consumers did not have difficulty in identifying products that were available.

Today many food preparations that contain meat substitutes are appearing. Fabricated meat from soybean and other protein sources are being interlaced with various fats and other ingredients to provide a wide range of nutrient composition. When food products are manufactured using this new technology, the consumer cannot know the nutritional attributes of the products unless nutritional information labeling is provided.

Numerous drinks that may or may not contain natural fruit juices in their formation are marketed. The FDA sets standards specifying the minimum contents of natural juices required in products.

INFORMATION SHEET #9

Care and Use of Laboratory Animals

Principles for the Utilization and Care of Vertebrate Animals Used in Testing, Research, and Teaching

I. The transportation, care, and use of animals should be in accordance with the Animal Welfare Act and other applicable Federal laws, guidelines and policies.

II. Procedures involving animals should be designed and performed with due consideration of their relevance to human or animal health, the advancement of knowledge, or the good of society.

III. The animals selected for a procedure should be of an appropriate species and quality and the minimum number required to obtain valid results. Methods such as mathematical models, computer simulation, and in vitro biological systems should be considered.

IV. Proper use of animals, including the avoidance or minimization of discomfort, distress, and pain when consistent with sound scientific practices, is imperative. Unless the contrary is established, investigators should consider that procedures that cause pain or distress in human beings may cause pain or distress in other animals.

V. Procedures with animals that may cause more than momentary or slight pain or distress should be performed with appropriate sedation, analgesia, or anesthesia. Surgical or other painful procedures should not be performed on unanesthetized animals paralyzed by chemical agents.

VI. Animals that would otherwise suffer severe or chronic pain or distress that cannot be relieved should be painlessly killed at the end of the procedure or, if appropriate, during the procedure.

VII. The living conditions of animals should be appropriate for their species and contribute to their health and comfort. Normally, the housing, feeding, and care of all animals used for biomedical purposes must be directed by a veterinarian or other scientist trained and experienced in the proper care, handling, and use of the species being maintained or studied. In any case, veterinary care should be provided as indicated.

VIII. Investigators and other personnel shall be appropriately qualified and experienced for conducting procedures on living animals. Adequate arrangements shall be made for their in-service training, including the proper and humane care and use of laboratory animals.

IX. Where exceptions are required in relation to the provisions of these Principles, the decisions should not rest with the investigators directly concerned but should be made, with due regard to Principle II, by an appropriate review group such as an institutional animal research committee. Such exceptions should not be made solely for the purposes of teaching or demonstration.[1]

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[1] Guide for the Care and Use of Laboratory Animals. NIH Publication No. 85-23, revised 1985. Institute of Laboratory Animal Resources, National Research Council. Available from U.S. Government Documents Bookstore. Taken from *The Science Workbook of Student Research Projects in Food - Agriculture - Natural Resources.* (1985). The Ohio State University.

INFORMATION SHEET #10

Vegetarians Eat More Than Vegetables

Vegetarians Eat Vegetables . . . that's obvious. But that's not all that they eat. It all depends on the kind of vegetarian they are.

- Vegans (VEJ en), or strict vegetarians, eat only plant foods like fruits, vegetables, nuts, and grains.
- Lacto-vegetarians use dairy products as well as plant foods.
- Ovo-lacto-vegetarians eat eggs in addition to dairy products and plant foods.

Some people follow a vegetarian diet in part. For instance, they may eat fish but not meat.

Choosing the Vegetarian Life

Many people around the world are vegetarians. Why do they choose this lifestyle?

- Economic reasons. A vegetarian diet costs less that one heavy with meat.
- Ecological reasons. For each pound of meat produced, animals must eat from 2 to 10 pounds of grain. If you cut down on meat consumption, there's more grain available for food.
- Philosophical reasons. Religious beliefs may prohibit or discourage eating meat. Many vegetarians simply do not believe in killing animals.
- Health reasons. A typical vegetarian diet has less fat and cholesterol and more fiber than a diet that includes meat. Nutritionists generally agree that vegetarians are rarely overweight.

Where's the Protein?

Mention a vegetarian diet to most people and they're likely to ask: "Where does the protein come from?" The answer is from the combination of foods eaten.

To meet their protein needs, vegetarians must choose the combination of foods they eat very carefully. The amino acids that one food lacks must be supplied by another food in the same meal. Combining incomplete proteins to make complete ones is called *protein complementarity.*

How does protein complementarity work? Here are three simple rules to remember:

Legumes + Grains = Complete Protein

Legumes + Nuts or Seeds = Complete Protein

Any Plant Protein + Eggs or Dairy Products = Complete Protein

Using these guidelines, it's easy to see that combinations like baked beans and corn bread, soybeans and sesame seeds, and potato salad made with eggs are complete protein sources.

Eating Right the Vegetarian Way

Like everyone else, vegetarians need not only protein but all the nutrients. Some nutrients, such as calcium, iron, and several B vitamins, are difficult to obtain if animal foods are not eaten. Ovo-lacto-vegetarians generally do not have problems getting a balanced diet because they eat eggs and milk. However, vegans must choose their foods very carefully. In place of milk, for instance, they should eat vegetables that are good sources of calcium. Vegans may need to take vitamin B_{12} supplements because that vitamin is not available in plant foods.

Does all this make a vegetarian diet seem complicated? It's really not — as long as you know the basics of good nutrition.

Reproduced with permission from *Food for Today.* Kowtaluk, Helen, and Kopan, Alice O. (1986). Glencoe Publishing Company.

TRANSPARENCY MASTER #1

Fat-Soluble Vitamins

Vitamin	Best Sources	Benefits	Too Little	Too Much
Vitamin A (Retinol)	Liver. Deep yellow fruits and vegetables: carrots, pumpkin, sweet potatoes, winter squash, apricots, cantaloupe, papayas, peaches. Dark green vegetables: broccoli, spinach, greens. Milk, cheese, eggs.	Helps eyes adjust to dim light. Keeps skin healthy. Helps promote growth. Helps resist infection by keeping linings of mouth, nose, throat, and digestive tract healthy.	Eyes become oversensitive to light. Night blindness may develop. Skin becomes rough and cracked. Resistance to infections lowered.	Headache; nausea. Dry, itchy skin. Skin may turn yellow. Stunted growth in children.
Vitamin D (Calciferol)	Made on skin in sunlight. Fortified milk. Cod liver oil.	Helps body use calcium and phosphorus. Needed for healthy strong bones and teeth. Helps keep nervous system and heart working properly.	Bones become soft and deformed. Teeth become soft. Body cannot absorb calcium properly. Phosphorous is retained in kidneys.	Nausea, loss of appetite, diarrhea. Kidney stones. Fragile bones. Deafness.
Vitamin E (Tocopherols)	Vegetable oils: corn, cottonseed, soybean; margarine. Wheat germ. Whole-grain cereals and bread. Liver. Green leafy vegetables.	Protects vitamin A and fatty acids from oxidation. Helps form red blood cells, muscles, and other tissues.	Blood cells may rupture. Muscles may become wasted. (Shortage is very rare among humans.)	Nausea, dizziness, blurred vision. Extreme fatigue and muscle weakness.
Vitamin K	Made by bacteria in human intestine. Green leafy vegetables. Cabbage. Cauliflower. Potatoes. Liver.	Helps for the substances needed for blood clotting.	In infants, hemorrhage (bleeding). In adults, loss of calcium from bones. (Shortage is very rare. People on antibiotics for a long time or those with impaired fat absorption may need extra vitamin K.)	In infants, jaundice.

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TRANSPARENCY MASTER #1 (Cont.)

Water-Soluble Vitamins

Vitamin	Best Sources	Benefits	Too Little	Too Much
Vitamin B_1 (thiamin)	Pork. Liver. Oysters. Whole-grain and enriched breads and cereals. Wheat germ. Legumes.	Helps body obtain energy from carbohydrates. Helps brain, nerves, and muscles function.	Mental confusion. Swelling of the heart. Numbness of hands and feet. Leg cramps.	Symptoms unknown.
Vitamin B_2 (riboflavin)	Milk, cheese. Liver, kidneys. Eggs. Dried beans and peas. Enriched breads and cereals.	Helps break down carbohydrates, proteins, and fats to release energy. Keeps lining of mouth, nose, and digestive tract healthy.	Cracked lips. Sore tongue. Skin disorders. Eyes become sensitive to light.	Symptoms unknown.
Niacin	Liver. Fish. Poultry. enriched breads and cereals. Eggs. Peanuts, dried peas and beans.	Helps break down food to provide energy	Sore, cracked skin. Sore mouth. Diarrhea. Mental confusion, anxiety.	Ulcers in the duodenum (tube leading from stomach to small intestine). Liver abnormalities. Increased level of blood sugar.
Vitamin B_6 (pyridoxine)	Meats, fish, poultry. Liver. Whole-grain cereals and bread. Wheat germ. Oatmeal. Potatoes. Green leafy vegetables. Avocados, bananas. Nuts.	Helps the body utilize proteins and fats. Helps form red blood cells.	Skin disorders. Dry, cracked lips. Nausea, dizziness. Anemia. Kidney stones. Depression.	High doses can lead to dependency. Symptoms of shortage appear when dose is decreased to normal. Some evidence that high doses cause joint stiffness.
Vitamin B_{12} (cobalamins)	Meats, fish, oysters. Liver, kidneys. Eggs. Dairy products. (Not available from plant sources.)	Helps form red blood cells. Needed for healthy nerves. Helps form genetic material.	B_{12} deficiency anemia: paleness, fatigue, heart fluttering. Numbness and tingling in hands and feet, loss of balance.	Symptoms unknown.
Pantothenic acid	Liver, kidneys. Eggs. Whole-grain cereals and bread. Nuts. Dark green vegetables. Made by bacteria in the human intestine.	Helps the body utilize proteins, carbohydrates, and fats. Assists in production of hormones.	Abdominal cramps, vomiting. Fatigue. Restlessness, inability to sleep. Tingling in hands and feet. (Shortage is very rare.)	Body's need for thiamin increases; symptoms of a thiamin shortage could develop.

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TRANSPARENCY MASTER #1 (Cont.)

Vitamin	Best Sources	Benefits	Too Little	Too Much
Biotin	Egg yolk. Liver, kidneys. Mushrooms. Peanuts. Dark green vegetables. Made by bacteria in human intestine.	Helps body make fatty acids. Helps release energy from carbohydrates.	Loss of appetite, nausea, vomiting. Fatigue, muscle pain. Depression. (Shortages unknown except in people who eat large amounts of raw egg white. The raw egg white destroys biotin.)	Symptoms unknown.
Folic acid	Liver, kidneys. Eggs. Dark green leafy vegetables. Dried peas and beans. Wheat germ.	Helps produce red blood cells. Helps in forming genetic material.	Anemia. In pregnant women, shortage can cause loss of baby or abnormalities in baby.	Could mask the symptoms of a B_{12} shortage.
Vitamin C (ascorbic acid)	Citrus fruits: oranges, grapefruit, tangerines, lemons. Strawberries, papayas, cantaloupes. Broccoli, raw cabbage, mustard and turnip greens, collards.	Works with calcium to build and maintain healthy bones and teeth. Keeps blood vessels strong. Protects other vitamins from oxidation. Helps form collagen. Helps body fight infection.	Bleeding gums. Loss of appetite, weight loss. Weakness. Thick, roughened skin.	Diarrhea. Dependency on high doses. Kidney and bladder stones.

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TRANSPARENCY MASTER #2

Major Nutritional Deficiency Diseases and Their Causes

Disease	*Cause*	*Major Symptoms*
Anemia	Lack of iron	Reduced level of hemoglobin in blood, paleness of skin, shortness of breath
Beri beri	Lack of thiamin	Leg cramps, atrophy of leg muscles, paralysis, nervous and cardiac disturbances
Goiter	Lack of iodine	Enlargement of thyroid gland (neck), birth defects in newborns
Kwashiorkor(mostly in underdeveloped countries)	Lack of protein	Skin rash, orange color of hair, retarded growth (children)
Marasmus(mostly in underdeveloped countries)	Lack of all nutrients	Atrophy of muscles, old age look (children), "skeleton" appearance
Osteoporosis and Osteomalacia	Chronic lack of calcium, often due to lack of vitamin D	Weakening of bone; pathological changes of bone, complications with healing fractured bones (adults)
Pellagra	Lack of niacin	Skin rash, dark and rough skin, bloody diarrhea, mental disorder
Rickets	Lack of vitamin D and calcium	Weak bones, leg deformities ("bow legs"), distorted ribs (children)
Scurvy	Lack of vitamin C	Hemorrhagic skin, gangrene of gums and loss of teeth, pains in joints

TRANSPARENCY MASTER #3

Energy Content of Food Components and Some Common Foods[a]

	Energy[b] Value/Gram	
A. Food Components	*Kcal*	*kJ*
Alcohol	7	28.8
Carbohydrate	4	16.5
Fat	9	37.0
Protein	4	16.5

	Energy Values/100g	
B. Common Foods	*Kcal*	*kJ*
Cheddar Cheese	360	1525
Granola	430	1800
Milk	66	280
Orange	36	150
Potato Chips	200	2080

[a] Source: Nutritive values of foods, by C.F. Adams and Martha Richardson, Home and Garden Bulletin #72, USDA, Washington, D.C., 1981.

[b] One Kcal (Kilocalorie) is the amount of heat energy needed to increase the temperature of 1kg of water by 1°C; One kJ (kilojoule) is the equivalent SI unit in metric system. 1Kcal = 4,184 kJ.

TRANSPARENCY MASTER #4

Approximate Energy Needed by Healthy Adults for Common Activities

	Energy Needs		
	Men	*Women*	*Average*
Type of Activity	*---kJ/day---*		*(kJ/hr)*
Sedentary — Light			
Eating, Watching T.V.	8,500-11,500	7,500-10,500	380
Moderate			
Swimming (Pleasure), Bicycling	13,000-15,000	11,000-12,500	1,700
Strenuous			
Forestry Work, Dancing	16,000-17,500	13,000-15,000	2,200
Very Strenuous			
Mountain Climbing, Competitive Sports, Heavy Work	18,000-20,000	16,500-17,000	4,500

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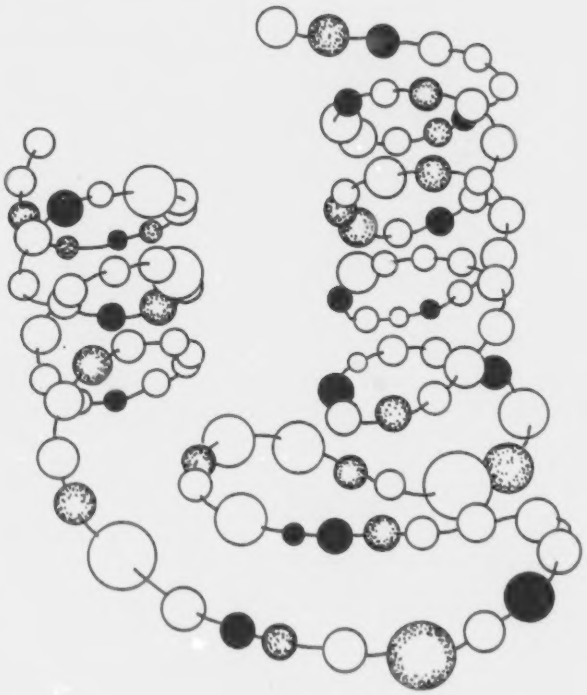
TRANSPARENCY MASTER #5

Schematic Illustration of Structure of a Protein Molecule



The dots represent the various amino acids (primary structural elements), linked together in a chainlike sequence (secondary structure), and coiled randomly or in a characteristic helical form (tertiary structure).

TRANSPARENCY MASTER #6

Amino Acids Essential for Humans

Isoleucine

Leucine

Lysine

Methionine

Phenylalanine

Threonine

Tryptophan

Valine

Histidine[a]

[a] Essential for children and possibly for adults.

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TRANSPARENCY MASTER #7

Nutritional Quality of Some Common Food Proteins[a]

Source of Protein	*Per*[b]	*Chemical Score*[c]
Whole Egg	3.9	100
Fish	3.5	70
Beef Steak	2.3	69
Whole Milk	3.1	60
Soybean	2.3	47
Rice	2.2	56
Peanuts	1.6	43
Wheat Flour	0.6	32

[a] Source: FAO Nutritional studies No. 24, Rome, 1970.

[b] Protein efficiency ratio (determined by experiments with rats); g weight gain/g protein received.

[c] Percentage of the most limiting amino acid in a given protein relative to egg protein.

TRANSPARENCY MASTER #8

Examples of Important Dietary Minerals and Their Main Functions in the Human Body

Element	*Average[a] Recommended Dietary Intake (mg/day)*	*Main Effect in Human Body*
Calcium	1,200	Building of bones, teeth, proper function of heart
Chlorine	2,500	Forms hydrochloric acid for gastric juices
Magnesium	300	Part of thyroid hormones
Iodine	150	Part of oxygen-transfer systems
Iron	15	Conversion of nutrients to energy
Phosphorus	1,200	Building of bones, teeth, regulation of energy release
Potassium	2,000	Control of nerve impulses
Sodium	2,000	Maintains water balance
Zinc	15	Digestion and metabolism of proteins
Thiamine (Vit B_1)	1.5	Part of coenzyme used in energy metabolism, supports nervous system function
Riboflavin (Vit B_2)	1.7	Part of coenzyme used in energy metabolism, supports vision and skin health
Niacin (Vit B_3)	20	Part of coenzyme used in energy metabolism, supports health of digestive and nervous system and skin
Vitamin C	60	Building of vessel walls, scar tissue, and bone; amino acid metabolism; resistance to infection

[a] Adapted from Recommended Daily Allowances, 9th edition. (1980). National Academy of Sciences — National Research Council, Food and Nutrition Board.

TRANSPARENCY MASTER #9

Approximate Micronutrient Content[a] of Selected Food Items

	Peas		Orange Juice		Salmon		Milk	
Micronutrient	Raw	Canned	Fresh	From Frozen Concentrate	Fresh, Broiled	Canned	Fresh (Pasteurized, 3.3% fat)	Fermented (Buttermilk, 0.1% fat)
	mg/100g							
Thiamine	0.3	0.1	0.1	0.1	0.2	—	—	—
Riboflavin	0.1	—[b]	—	—	0.2	0.2	0.2	0.2
Niacin	2.9	0.8	0.4	0.3	9.9	7.4	0.1	0.1
Vitamin C	27.0	8.0	49.6	47.3	—	—	0.9	1.0
Calcium	26.2	26.2	10.8	10.0	—	—	118.0	122.0
Iron	1.9	1.9	0.2	0.1	1.2	1.0	—	—
Phosphorus	116.8	77.0	16.8	16.8	417.3	288.2	90.8	95.7
Potassium	318.4	96.6	198.4	198.4	446.4	339.1	143.4	141.1

[a] Source: Nutritive values of foods, by C.F. Adams and Martha Richardson, Home and Garden Bulletin #72, USDA, Washington, D.C., 1981.

[b] Less than 0.1 mg/100 g.

TRANSPARENCY MASTER #10

Proximate Composition of Some Raw Food Materials (Orientation Values)[1]

	Water	Protein	Fat	CHO (Including Fiber)	Ash
			% Total Weight		
I. Animal Origin					
Eggs, Whole					
(Without Shell)	73.0	13.0	12.0	1.0	1.0
White (58% Total Weight)	88.0	11.0	trace	0.8	0.7
Yolk (31% Total Weight)	52.0	16.0	30.0	0.5	1.5
Meat and Poultry (Average Values)					
Beef	60.0	18.0	21.0	trace	1.0
Chicken	75.0	19.0	5.0	trace	0.8
Duck	62.0	21.0	16.0	trace	1.0
Pork	37.0	10.0	52.0	trace	0.5
Turkey	64.0	20.0	15.0	trace	1.0
Fish and Seafood					
Cod	81.0	18.0	0.3	trace	1.0
Fatty Fish (Eel)	65.0	16.0	18.0	trace	0.2
Oyster	84.0	9.0	2.0	3.0	2.0
Shrimp	78.0	18.0	1.0	1.5	1.5
Milk					
Cow's	87.0	3.5	3.5-5.0	5.0	0.7
Goat's	87.0	3.2	4.0	4.5	0.7

	Water	Protein	Fat	CHO (Including Fiber)	Ash
	% Total Weight				
II. Plant Origin					
Fruits and Vegetables					
Apple	84.0	0.2	0.6	15.0	0.3
Green Peas	78.0	6.0	0.4	15.0	1.0
Lettuce	95.0	1.0	0.2	3.0	1.0
Orange	86.0	1.0	0.2	12.0	0.6
Potato	80.0	2.0	0.1	17.0	0.9
Tomato	93.0	1.0	0.2	5.0	0.5
Grains, Pulses, and Oilseeds (Dry)					
Peanuts	5.0	26.0	48.0	19.0	2.0
Rapeseed	7.0	18.0	45.0	26.0	4.0
Rice	12.0	7.0	0.4	80.0	0.5
Soybean	8.0	40.0	18.0	30.0	4.0
Sunflower	4.0	23.0	50.0	20.0	3.0
Wheat	13.0	14.0	2.2	69.0	1.7

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[1] Source: Nutritive values of foods, by C.F. Adams and Martha Richardson, Home and Garden Bulletin #72, USDA, Washington, D.C., 1981.

TRANSPARENCY MASTER #11

Proximate Composition of Some Processed Foods (Orientation Values)[1]

	Water	Protein	Fat	CHO (Including Fiber)	Ash
	% Total Weight				
Beer	92.0	0.3	0.0	4.0	0.2
Bologna	57.0	13.0	23.0	4.0	3.0
Breakfast Cereals (Cornflakes, Unsweetened, Enriched)	4.0	8.0	0.5	85.0	2.5
Cheddar Cheese	37.0	25.0	32.0	2.0	4.0
Frozen Pizza with Cheese	50.0	12.0	8.0	27.0	3.0
Ice Cream	63.0	4.0	11.0	21.0	1.0
Strawberry Jam	29.0	0.5	0.1	70.0	0.3
White Bread	36.0	9.0	3.0	50.0	2.0

[1] Source: Nutritive values of foods, by C.F. Adams and Martha Richardson, Home and Garden Bulletin #72, USDA, Washington, D.C., 1981.

TRANSPARENCY MASTER #12

Food Additives

A. Food Additive Definition

B. Why Use Food Additives?

C. Testing for Food Additive Safety

D. Risks and Benefits of Additives

E. Classes of Food Additives

1. Preservatives
2. Antioxidants
3. Sequestrants
4. Surface Active Agents
5. Stabilizers, Thickeners
6. Bleaching and Maturing Agents, Starch Modifiers
7. Buffers, Acids, Alkalies
8. Food Colors
9. Nonnutritive and Special Dietary Sweeteners
10. Nutrient Supplements
11. Flavoring Agents

STUDENT ACTIVITIES

STUDENT WORKSHEET #1 — Carbohydrates, Fats, and Proteins

STUDENT WORKSHEET #2 — Food and Energy Word Search (with solution)

STUDENT WORKSHEET #3 — Effects of Different Nutrients on Satiety Laboratory Experiment

STUDENT WORKSHEET #4 — Nutrition Studies Using Chicks Laboratory Experiment

STUDENT WORKSHEET #5 — The American Diet: Is it Adequate?

STUDENT WORKSHEET #6 — Food Additives

STUDENT WORKSHEET #7 — Food Additives Word Search (with solution)

For additional activities, teachers may refer to the "Suggested Teaching Activities and Procedures" section in the Instructor's Guide.

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STUDENT WORKSHEET #1

Carbohydrates, Fats, and Proteins

Match the items listed in the right column with either carbohydrates, fats, or proteins in the left column.

1. __________ Carbohydrates

2. __________ Fats

3. __________ Proteins

A. Egg yolks
B. Made up of amino acids
C. Butter and margarine
D. Made of C, H, and O
E. Fruits
F. Fish
G. Make up 75% of solid body matter
H. Starches
I. Should make up 55% of person's daily caloric intake
J. About 30% of calories should come from this
K. Sucrose
L. If eaten in excess, will be changed into fat

STUDENT WORKSHEET #1 — Key

Carbohydrates, Fats, and Proteins

Match the items listed in the right column with either carbohydrates, fats, or proteins in the left column.

1. *D,E,H,I,K,L* Carbohydrates

2. *A,C,J* Fats

3. *B,F,G,L* Proteins

A. Egg yolks
B. Made up of amino acids
C. Butter and margarine
D. Made of C, H, and O
E. Fruits
F. Fish
G. Make up 75% of solid body matter
H. Starches
I. Should make up 55% of person's daily caloric intake
J. About 30% of calories should come from this
K. Sucrose
L. If eaten in excess, will be changed into fat

STUDENT WORKSHEET #2

Food and Energy Word Search

X	I	N	Z	I	L	Y	G	R	E	N	E	G	C	U	C	F
K	H	S	A	N	U	M	A	L	L	A	V	F	N	J	Q	D
N	U	C	E	S	Q	Q	Y	C	Q	G	L	X	O	X	O	L
I	M	L	K	L	E	M	P	H	S	U	H	F	Q	O	M	S
X	J	K	A	R	B	T	X	R	T	U	R	S	R	U	D	X
O	B	T	F	I	K	A	A	H	O	L	C	P	I	U	E	R
W	J	C	A	L	T	R	T	R	L	T	A	R	L	F	I	J
S	I	R	I	P	L	N	Y	E	D	M	E	E	O	A	G	T
L	F	M	B	Q	R	L	E	M	G	Y	I	I	H	S	N	W
C	T	C	L	M	D	E	A	S	S	E	H	R	N	Z	E	T
H	S	T	A	A	L	R	T	D	S	E	V	O	Y	S	D	G
V	P	I	I	L	G	P	G	T	A	E	H	Z	B	B	A	R
R	J	R	E	A	O	G	E	Z	U	J	N	C	M	R	T	E
F	Y	Z	R	S	N	R	S	G	D	B	F	J	R	I	A	E
L	A	I	V	W	D	M	I	I	G	Q	B	B	P	A	D	C
X	N	T	N	J	Q	H	E	E	N	S	C	N	X	G	T	K
E	G	X	S	R	W	Y	Y	N	V	U	L	E	S	W	G	S

The following words are hidden in the puzzle:

Animal
Butter
Calorie
Carbohydrates
Dairy
Eggs
Energy
Essential
Fats
Fish

Food
Fruit
Health
Margarine
Milk
Plant
Proteins
Starches
Sucrose
Vegetables

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STUDENT WORKSHEET #2 — Key

Food and Energy Word Search

•	•	•	•	•	•	Y	G	R	E	N	E	•	•	•	•	•
•	•	S	A	N	I	M	A	L	•	•	•	F	•	•	•	•
•	•	•	E	S	•	•	•	•	•	•	•	•	O	•	•	•
•	•	L	•	L	E	•	P	H	S	•	H	F	•	O	•	•
•	•	•	A	•	B	T	•	R	T	U	•	S	R	•	D	•
•	•	•	•	I	K	A	A	•	O	L	C	P	I	U	•	•
•	•	•	•	L	T	•	T	R	•	T	A	R	L	F	I	•
•	•	•	I	•	•	N	•	E	D	•	E	E	O	A	•	T
•	•	M	•	•	R	•	E	M	G	Y	•	I	H	S	N	•
•	•	C	•	•	D	E	A	S	S	E	H	•	N	•	E	T
•	•	•	A	A	•	R	T	•	S	E	V	O	•	S	•	•
•	•	•	I	L	G	•	•	T	•	E	H	•	B	•	•	•
•	•	R	•	A	O	•	E	•	U	•	•	C	•	R	•	•
F	Y	•	R	•	•	R	•	G	•	B	•	•	R	•	A	•
•	A	I	•	•	•	•	I	•	G	•	•	•	•	A	•	C
•	N	T	•	•	•	•	•	E	•	S	•	•	•	•	T	•
E	•	•	S	•	•	•	•	•	•	•	•	•	•	•	•	S

The following words are hidden in the puzzle:

Animal
Butter
Calorie
Carbohydrates
Dairy
Eggs
Energy
Essential
Fats
Fish

Food
Fruit
Health
Margarine
Milk
Plant
Proteins
Starches
Sucrose
Vegetables

STUDENT WORKSHEET #3

Effects of Different Nutrients on Satiety Laboratory Exercise

Background

Although people in many parts of the world are starving or malnourished, the biggest nutritional problem in Western society is obesity. To a great extent, appetite controls food intake. Fats, carbohydrates, and proteins do not have equal caloric density; fat has 9 Cal/gm while carbohydrates and proteins each have approximately 4 Cal/gm. Fat has long been known to have a high satiety value. Is that because it has more calories/unit weight or because its chemical composition triggers some specific reaction in the body?

Purpose

1. To attempt to determine whether the high satiety value of fat is due to its nutrient density or to its chemical composition.

Materials and Methods

This project will necessitate using laboratory rats and must employ safe and ethical laboratory procedures. At no time during these experiments will any of the animals suffer unnecessary stress and none of the procedures will involve any pain to the animals.

This experiment will require separate cages for the animals, a balance accurate to .1 gm, and accurate and careful record keeping.

This experiment can be accomplished using meal-fed rats which have been trained to consume their daily ration in a set period of time (3 hrs). Thus, a two-week acclimation period will be required to train the rats. First, rats are randomly assigned to one of three groups. At the same time each day, a weighed amount of food is offered to each rat individually for 3 hours. At the end of the three-hour period, the food cups are removed and the food is reweighed in order to calculate the daily food consumption. Rats must be weighed daily during this period to accustom them to the procedure. By knowing how many calories/gm the food contains (usually available from the manufacturer), it is possible to calculate the daily food intake.

In the second part of the study, weighed amounts of food will be offered to the rats for 30 minutes, then removed from the cages and reweighed. At this time .5 cc of fat (corn oil) or sugar solution (sucrose) or protein (casein) is injected into the rat's mouth using a calibrated eye dropper. Then the normal food is returned to the cage for the rest of the three-hour eating period after which the food is weighed again. The total calorie intake per day can then be calculated taking into account the calories injected into the rats' mouths. Rats should also be weighed daily to determine whether there is a significant difference in weight gain between the groups. If the satiety effect of fat is merely a function of its greater caloric density, then the total calories consumed by each group will be the same. It fat induces satiety by a chemical means, then fewer calories will be consumed by the group receiving corn oil.

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STUDENT WORKSHEET #4

Nutrition Studies Using Chicks Laboratory Exercise

Background

Approximately 40 different nutrients must be supplied by the feed if a chick is to grow well and remain healthy. An example of a diet which will meet nutritional needs for a chick from 0 to 28 days is given in Table 1. Ingredients which supply energy or calories take up more than half of a typical diet for a chick. Amino acids, which the chick receives by digesting protein, vary from as low as .2 percent of the diet to as high as 3 percent of the diet. About 20 different amino acids are in protein. The amounts of macrominerals, such as calcium, phosphorus, and sodium, range from .15 percent to about 1 percent of the diet. Other nutrients, such as vitamins and trace minerals, need to be present in very small amounts. Their amounts are usually measured as parts per million (ppm) or milligrams per kilogram of diet (mg/kg). A deficiency of any one of these nutrients will affect the growth and health of the chick.

Table 1. Ingredients in a chick starter diet.

		Nutrient supplied	
Ingredient	% by Wt.	Primary	Secondary
Corn	53.30	Energy	Protein
Soybean meal	38.00	Protein	Energy
Fat or oil	5.00	Energy	
Dicalcium phosphate	1.70	Phosphorus	Calcium
Limestone	1.20	Calcium	
Salt	.40	Sodium	
Vitamin mix*	.25	Vitamins	
Trace mineral mix**	.05	Trace minerals	
Methionine	.10	Amino acid	

* A chick needs vitamins A,D,E,K,B_6,B_{12}, thiamin, riboflavin, niacin, pantothenic acid, folic acid, and biotin. Choline is also usually added.

** A chick needs copper, iron, manganese, selenium, and zinc.

Design

When nutritional study is conducted, at least two groups of chicks should be used. One group should be fed the "control" diet, — the diet which is nutritionally adequate. This group will be the standard for comparison. A second group should be fed a diet which is nutritionally modified. Because of variation among chicks, at least five chicks should be in each group to provide an accurate answer. More chicks per group are needed if treatment differences are fairly small.

Project Ideas

1. For the easiest type of project, a feed ingredient can be omitted from the experimental diet and the effects on the chicks can be observed. You can use subjective results such as the effect on the activity and behavior of the chicks. You can use objective measures such as the daily or weekly weight gain of the chicks and the amount of feed eaten each day or week.

2. A more difficult variation might be to find out which vitamins need to be included in the vitamin mix. Corn and soybean meal contain at least a little of all the vitamins. In the case of some vitamins, corn and soybean meal provide enough to meet a chick's requirement. Therefore, none of that vitamin needs to be included in the vitamin mix. In other cases corn and soybean meal do not provide enough of the vitamin, so that vitamin must be included in the vitamin mix in order to prevent a deficiency.

   In order to determine if a vitamin needs to be included in the vitamin mix, the control diet should contain all vitamins. The experimental diet should omit the vitamin in question. Subjective and objective results will indicate if the vitamin needs to be added. In some cases, chicks will develop a physical problem which indicates a specific vitamin deficiency.

3. If a vitamin should be included in the vitamin mix, it is possible to find out how much should be added. Different groups of chicks should be fed graded levels of the vitamin. At the point where higher levels of the vitamin no longer improve health or growth, the requirement has been reached.

4. If you want to find out the total amount of vitamin needed, i.e., the vitamin in the mix plus that in the corn and soybean meal, then an assay for that nutrient must be done. A method of assay is available for each nutrient and most assay procedures use chemical or microbiological tests. Tests are also available to show how nutrient levels in the diet affect nutrient levels in tissues or blood.

5. Another possibility is to use the chick for a biological assay. If the diet is deficient in a nutrient, then that diet can be used to compare amounts of that nutrient supplied by different foods or feeds. For example, assume that a diet has been found to be deficient in riboflavin. If you substitute 5 percent brewer's yeast for 5 percent soybean meal, the chicks fed the diet with 5 percent brewer's yeast will probably grow faster and be healthier. You could conclude that brewer's yeast is a better source of riboflavin than soybean meal. By designing the proper experiment you could also determine how much better brewer's yeast is than soybean meal.

References

1. *Association of Official Analytical Chemists Handbook*. AOAC: Arlington, VA. (This book contains the official method of analysis for most of the nutrients.)

2. *Nutrient Requirements of Poultry*. 8th ed. National Academy of Sciences: Washington, DC. (This book gives the nutrient content of feed ingredients, lists nutrient requirements for poultry, describes the effect of each nutrient deficiency, and supplies other references.)

3. For additional help contact the author at address below.

Submitted by Dr. David Latshaw, Department of Poultry Science, The Ohio State University, 674 West Lane Ave., Columbus, OH 43210. Taken from *The Science Workbook of Student Research Projects in Food - Agriculture - Natural Resources*. (1985). The Ohio State University.

STUDENT WORKSHEET #5

The American Diet: Is it Adequate?

Answer the following questions in relation to the supervised study assignment in item 14 of the suggested teaching activities.

Multiple Choice

_____ 1. The deficiency of nutrients in the U.S. diet stems from

A. an inability to pay for the correct foods
B. an inability to choose the correct foods
C. there is no deficiency problem; the only problem is oversupply
D. A and B above
E. none of the above

_____ 2. Typical American diets are most frequently deficient in which of the following nutrients?

A. protein
B. vitamin C
C. calcium
D. bioflavanoids
E. phosphorus

_____ 3. The black population surveyed in the Ten-State Nutrition Survey was most deficient in

A. iron
B. vitamin A
C. vitamin B_1
D. protein
E. calcium

_____ 4. The Ten-State Nutritional Survey of 1968-1970 showed the highest prevalence of deficiencies in

A. iron, calories, vitamin A, riboflavin
B. vitamin A, riboflavin, fiber
C. iron, riboflavin, fiber
D. iron and fiber
E. iron, vitamin A, and riboflavin

_____ 5. In the University of Minnesota student diet survey the two most lacking nutrients for women, besides iron, were

A. protein and vitamin C
B. calcium and phosphorus
C. calcium and vitamin A
D. vitamin A and thiamin
E. thiamin and vitamin C

_____ 6. Food disappearance in USDA tables is based on

A. actual food consumption per capita
B. U.S. food production statistics per capita
C. the food balance of payments per capita
D. per capita production plus imports
E. per capita imports minus exports plus production

Essay Questions

1. Discuss the major malnutrition problems found in the United States.

2. What is food disappearance data? How can it be related to nutritional status?

3. How does the government assess nutrition status?

4. Are fast food meals worthless to the human body?

5. Which age group has the worst nutrient intake status? How can this be improved?

6. Are there overnutrition problems in the United States? Explain your answer.

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STUDENT WORKSHEET #6

Food Additives

Match the food additive with its correct definition.

1. ______ Antioxidants
2. ______ Stabilizers, Thickeners
3. ______ Food Colors
4. ______ Preservatives
5. ______ Flavoring Agents
6. ______ Nutrient Supplements
7. ______ Bleaching and Maturing Agents, Starch Modifiers
8. ______ Buffers, Acids, Alkalies
9. ______ Sequestrants
10. ______ Nonnutritive and Special Dietary Sweeteners
11. ______ Surface Active Agents

A. Natural includes spices, herbs, essential oils, and plant extractives.
B. Vitamins and minerals added as supplements and enrichment mixtures to food products.
C. Examples include saccharin, cyclamates, and nutrasweet.
D. Added to thousands of foods to give consumers the appetizing and attractive qualities desired.
E. pH-adjusting and pH-controlling chemicals.
F. Whitens the yellow color of milled flour. Whitens the color of milk for cheese manufacturing.
G. Additives that stabilize and thicken foods.
H. Used to stabilize oil-in-water and water-in-oil mixtures, gas-in-liquid mixtures, and gas-in-solid mixtures.
I. Combine with trace metals such as iron and copper and remove them from solution.
J. Compounds used to prevent oxidation of fat (rancidity).
K. Prevent or inhibit the growth of bacteria, yeasts, and molds.

STUDENT WORKSHEET #6 — Key

Food Additives

Match the food additive with its correct definition.

1. *J* Antioxidants
2. *G* Stabilizers, Thickeners
3. *D* Food Colors
4. *K* Preservatives
5. *A* Flavoring Agents
6. *B* Nutrient Supplements
7. *F* Bleaching and Maturing Agents, Starch Modifiers
8. *E* Buffers, Acids, Alkalies
9. *I* Sequestrants
10. *C* Nonnutritive and Special Dietary Sweeteners
11. *H* Surface Active Agents

A. Natural includes spices, herbs, essential oils, and plant extractives.
B. Vitamins and minerals added as supplements and enrichment mixtures to food products.
C. Examples include saccharin, cyclamates, and nutrasweet.
D. Added to thousands of foods to give consumers the appetizing and attractive qualities desired.
E. pH-adjusting and pH-controlling chemicals.
F. Whitens the yellow color of milled flour. Whitens the color of milk for cheese manufacturing.
G. Additives that stabilize and thicken foods.
H. Used to stabilize oil-in-water and water-in-oil mixtures, gas-in-liquid mixtures, and gas-in-solid mixtures.
I. Combine with trace metals such as iron and copper and remove them from solution.
J. Compounds used to prevent oxidation of fat (rancidity).
K. Prevent or inhibit the growth of bacteria, yeasts, and molds.

STUDENT WORKSHEET #7

Food Additives Word Search

E	G	O	U	S	S	T	N	E	I	R	T	U	N	B	C	M	W	S	I
P	M	O	E	C	O	L	O	R	I	N	G	K	F	B	B	Z	E	Z	P
D	T	F	A	V	T	K	S	B	A	X	I	N	Z	I	L	I	G	C	U
C	F	L	K	H	L	A	L	M	S	D	V	N	J	Q	L	D	N	U	C
Q	Q	A	S	Y	Q	E	G	U	O	L	D	X	X	A	O	L	I	M	K
M	U	V	Q	R	A	M	R	S	S	D	X	I	K	J	S	K	R	X	R
U	X	O	P	C	E	F	O	B	T	T	I	L	T	T	A	F	H	E	R
W	J	R	H	R	A	N	C	S	A	N	A	F	N	I	S	C	R	L	J
S	I	I	R	C	E	P	E	L	E	Y	A	E	I	R	V	M	I	G	L
F	N	N	E	B	Q	S	L	K	I	Q	M	D	E	E	Y	E	W	D	C
G	T	G	L	M	G	A	E	R	C	E	U	Z	I	R	R	Z	S	S	S
H	S	S	T	L	G	N	D	R	L	I	I	E	A	X	Y	S	R	D	G
V	P	I	P	E	G	A	I	P	V	L	H	T	S	Z	O	E	B	A	R
R	J	E	N	G	Z	J	P	R	I	A	E	T	N	T	F	I	M	T	E
Z	S	T	N	S	D	U	F	B	U	I	T	J	I	F	R	E	T	L	V
W	S	D	M	I	S	Q	A	B	D	T	J	I	U	P	D	A	X	N	N
J	Q	H	E	N	C	T	N	X	G	K	A	B	V	G	X	R	N	W	A
Y	Y	N	V	U	S	L	E	S	W	G	X	M	E	E	N	K	N	T	P
Z	E	S	W	E	E	T	N	E	R	S	X	R	J	L	S	F	O	P	S
H	B	W	B	U	D	I	B	B	U	G	U	Q	F	T	J	B	P	R	K

The following words are hidden in the puzzle:

Acids
Additives
Agents
Alkalies
Antioxidants
Bleaching
Buffers
Coloring
Dietary
Flavorings

Maturing
Modifiers
Nutrients
Preservatives
Sequestrants
Stabilizers
Supplements
Surface
Sweeteners
Thickeners

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STUDENT WORKSHEET #7 — Key

Food Additives Word Search

•	•	•	•	•	S	T	N	E	I	R	T	U	N	•	•	•	•	S	•
P	M	O	E	C	O	L	O	R	I	N	G	•	•	•	•	•	E	•	•
•	•	F	•	•	•	•	•	B	A	•	•	•	•	•	•	I	•	•	•
•	•	L	•	•	•	•	L	M	S	D	•	•	•	•	L	•	•	•	•
•	•	A	S	•	•	E	•	U	O	•	D	•	•	A	•	•	•	•	•
•	•	V	•	R	A	•	R	S	•	D	•	I	K	•	S	•	•	•	•
•	•	O	P	C	E	F	•	•	T	•	I	L	T	T	A	•	•	•	•
•	•	R	H	R	A	N	•	S	•	N	A	F	N	I	S	C	•	•	•
•	•	I	•	C	E	•	E	•	E	•	A	E	I	R	V	•	I	•	•
•	N	N	E	•	•	S	•	K	•	Q	M	D	E	E	Y	E	•	D	•
G	•	G	•	•	G	A	E	•	C	E	U	Z	I	R	R	•	S	S	S
•	•	S	•	•	G	N	•	R	L	I	I	E	A	X	•	S	R	•	•
•	•	•	•	E	•	•	I	P	V	L	H	T	S	•	O	E	•	•	•
•	•	•	N	•	•	•	P	R	I	A	E	T	•	T	F	I	•	•	•
•	•	T	•	•	•	U	•	B	U	I	T	•	•	F	R	•	T	•	•
•	S	•	•	•	S	•	A	•	D	T	•	I	U	•	•	A	•	N	•
•	•	•	•	•	•	T	•	•	•	•	A	B	V	•	•	•	N	•	A
•	•	•	•	•	S	•	•	•	•	•	•	M	•	E	•	•	•	T	•
•	•	S	W	E	E	T	N	E	R	S	•	•	•	•	S	•	•	•	S
•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•

The following words are hidden in the puzzle:

- Acids
- Additives
- Agents
- Alkalies
- Antioxidants
- Bleaching
- Buffers
- Coloring
- Dietary
- Flavorings
- Maturing
- Modifiers
- Nutrients
- Preservatives
- Sequestrants
- Stabilizers
- Supplements
- Surface
- Sweeteners
- Thickeners

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CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Food Science and Technology

PROBLEM AREA: Packaging and Distributing Food Products

RELATED PROBLEM AREAS:

1. Understanding Food Science Technology (Central Core Cluster)
2. Marketing Agricultural Products and Services
3. Processing Agricultural Products
4. Adhering to Government Regulations
5. Marketing Horticultural Products and Services (Horticulture Cluster)

PREREQUISITE PROBLEM AREA(S):

1. Understanding Food Science Technology (Central Core Cluster)

LEVEL: Preparatory

OCCUPATIONAL TASKS ADDRESSED:

Agricultural Business and Management Cluster

Duty C: Performing Sales Related Duties

1. Package customer purchase
2. Arrange delivery of merchandise

Duty Q: Loading, Securing, Transporting, and Unloading Agricultural Products

1. Load livestock and other products
2. Secure loads and tag for shipping

Horticulture Cluster

Duty F: Harvesting Fruit and Vegetable Crops

1. Deliver baskets or boxes to grader or market
2. Load pallets on truck or trailor

Duty I: Storing, Shipping, and Taking Inventory

1. Load trucks and trailors for drop shipment
2. Transport products
3. Package orders for shipment
4. Store received supplies

STATE GOALS FOR LEARNING:

In planning the instruction for this problem area, teachers can promote the development of several student learning objectives which are related to the State Goals for Learning in Biological and Physical Sciences. These objectives are listed on the Learning Assessment Plan forms included on the following page(s). Those learning objectives marked with an asterisk (*) are taken from the sample lists provided by the Illinois State Board of Education.

Illinois Agricultural Core Curriculum
Agricultural Education 124 Mumford Hall 1301 W Gregory Drive University of Illinois Urbana, IL 61801

Director: Dale A. Law, Ed.D.
Principal Investigator: Jerry D. Pepple, Ed.D.
Research Assistant: Randy J. Bernhardt

Illinois Agricultural Core Curriculum Rev.

Submission Date ____________
☐ Original submission ☐ Revision
Page ____ of ____

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☒ Sciences ☐ Physical Development/Health

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)
COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐
District Name
City

II. STATE GOAL FOR LEARNING
As a result of their schooling, students will have a working knowledge of the concepts and basic vocabulary of biological, physical, and environmental sciences and their application to life and work in contemporary technological society.

Contact Person: ____________
Title: ____________
Phone: (   )

By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:

III. LEARNING OBJECTIVES	IV. ASSESSMENT A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	V. EXPECTATIONS Percent of Students Expected to Achieve Objective
1. Understand the purpose of food packaging.					
2. Understand the requirements and functions of containers.					
3. Understand the types of containers and packaging materials.					
4. Understand the effects of packaging on food stability.					
5. Describe the role of packaging in the food distribution chain.					

Packaging and Distributing Food Products

Agricultural Business and Mangement
Food Science and Technology

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Food Science and Technology

PROBLEM AREA: Packaging and Distributing Food Products

STUDENT LEARNING OBJECTIVES

Upon completion of their study of this problem area, students will be able to:

1. Understand the purpose of food packaging.
2. Understand the requirements and functions of containers.
3. Understand the types of containers and packaging materials.
4. Understand the effects of packaging on food stability.
5. Describe the role of packaging in the food distribution chain.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Food Science and Technology

PROBLEM AREA: Packaging and Distributing Food Products

PROBLEMS AND QUESTIONS FOR STUDY	INSTRUCTOR'S NOTES AND REFERENCES
1. What is the purpose of food packaging?	
2. What are the requirements and functions of containers?	
3. What are some types of containers?	
4. What are some types of packaging materials?	
5. What is laminated packaging material?	
6. What are the effects of food packaging on food stability?	
7. What is modified atmosphere packaging?	
8. What is the role of packaging in the food distribution chain?	

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INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Food Science and Technology

PROBLEM AREA: Packaging and Distributing Food Products

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES

1. Ask students, "What do you think are the purposes for food packages?" Have this question lead into a discussion on the purpose of food packaging.
2. Ask students, "What are the requirements of a good food container?" Discuss requirements and functions of containers.
3. Have students complete Student Worksheet #l.
4. Discuss with students the types of containers used in food packaging.
5. Discuss the different materials used for food packaging.
6. Take the class on a field trip to a food packaging business. Have an employee, while he or she conducts a tour of the facility for the students, explain to them the various steps in the processing of foods.
7. Have students complete Student Worksheet #2.
8. Discuss laminated packaging materials with the students. If possible, try to obtain a sample of laminated packaging material for students to examine.
9. Discuss with the class some general effects of food packaging on food stability.
10. Explain modified atmosphere packaging to the students.
11. Discuss with students the role of packaging in food distribution.
12. Have students research the flow of a specific agricultural product from producer to consumer. Create a flow chart showing the people, events, businesses, and distribution involved with this product. Include the changing of the product from a raw state to a consumable state and also show distribution of the product.
13. Discuss the ethical considerations concerning food tampering and packaging regulations as they relate to liability and consumer safety.

INSTRUCTOR'S NOTES AND REFERENCES

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INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Food Science and Technology

PROBLEM AREA: Packaging and Distributing Food Products

REFERENCES

INSTRUCTOR'S NOTES AND REFERENCES

*1. *Principles of Food Packaging*. (1980). Sacharow, S., Griffin, R.C., Jr. AVI Publishing Company, Inc., 250 Post Road East, P.O. Box 831, Westport, CT 06881.

*2. *Food Science*. (1986). Potter, Norman N. 4th Edition. AVI Publishing Company, Inc., c/o Van Nostrand Reinhold, 115 Fifth Ave., New York, NY 10003.

*3. *Introduction to Food Processing*. (1985). Jelen, Pavel. Reston Publishing Company, Inc., A Prentice-Hall Company, Reston, VA 22090.

*Indicates highly recommended references

INSTRUCTIONAL RESOURCES

These resources are intended for use by teachers in planning and teaching the materials for this problem area and may be adapted to fit the teaching method(s) used.

INFORMATION SHEET #1 — Purpose of Food Packaging

INFORMATION SHEET #2 — Requirements and Functions of Food Containers

INFORMATION SHEET #3 — Types of Containers

INFORMATION SHEET #4 — Laminated Packaging Materials

INFORMATION SHEET #5 — Effects of Food Packaging on Food Stability

INFORMATION SHEET #6 — Modified Atmosphere Packaging

INFORMATION SHEET #7 — Role of Packaging in the Food Distribution Chain

TRANSPARENCY MASTER #1 — Purpose of Food Packaging

TRANSPARENCY MASTER #2 — Requirements and Functions of Containers

TRANSPARENCY MASTER #3 — Functions of Packaging Materials

TRANSPARENCY MASTER #4 — Types of Containers

TRANSPARENCY MASTER #5 — Papers Used as a Food Packaging Material, and Plastic Films Used in Food Packaging

TRANSPARENCY MASTER #6 — Construction of the Laminated Packaging Material Used by Tetra-brik Aseptic Machinery

INFORMATION SHEET #1

Purpose of Food Packaging

The traditional purpose of food packaging has been protection against deterioration due to damaging effects of our environment, especially contamination by microorganisms, dirt, unintentional chemical adulterants, as well as physical and chemical spoilage by light, oxygen, water, or drying out.

Recently, packaging assumed an important role of information and content identification, as well as that of a marketing tool including advertising, sales promotion, and various convenience features.

In the example of weiners, canned foods, and sterilized milk, the packaging becomes an integral part of the food processing technology.

In other cases, packaging serves mainly as a convenience tool for easy handling (liquid foods, cookies, nuts, etc.), or even as a serving utensil (yogurt, TV dinners, etc.).

INFORMATION SHEET #2

Requirements and Functions of Containers

The following are among the more important general requirements and functions of food containers:

1. Nontoxic and compatible with the specific food — Containers should cause no color changes, flavor changes, or chemical reactions in the food.

2. Sanitary protection — Protection should be provided against the introduction of microorganisms and dirt, and resistance provided against the boring of insects and chewing of rodents.

3. Moisture and fat protection — Dry food should not absorb moisture from the atmosphere and moist food should not lose moisture to the atmosphere. Exceptions are respiring vegetables, which require permeable film containers that allow escape of moisture.

4. Gas and odor protection — Off-odors should be sealed out but desirable odors, such as the aroma of coffee or the essence of vanilla, should be sealed in.

5. Light protection — Most foods are light sensitive at least to a small degree. The choice of container must take into account the probable shelf life of the product and how much damage light will do in this time period.

6. Resistance to impact — Container should be nonbreakable, thus preventing product contamination subsequent to a breakage. Resistance to product damage from impact or other physical stress is also wanted.

7. Transparency — A transparent package is desirable because customers like to see what is purchased.

8. Tamper-resistant or tamper-evident — Lids with slightly concave domes that are drawn in when the jars are vacuum-packed are commonly used. Upon opening and breaking of the vacuum, a click is heard, assuring the customer that the air-tight seal has not been previously broken either by intent or from faulty closure during packaging. Other tamper-indicating devices for different products are plastic bands that seal closed a container, and membrane films sealed across the mouth of a container beneath the removable lid.

9. Ease of opening — The force used to effect container closure must be strong enough to prevent the seal bursting from internal pressure but not so strong as to prevent ease of opening.

10. Pouring features — Pourability is required in containers for many granular and particle solids, from breakfast cereals to salt, as well as liquids.

11. Reseal features — This feature has long been provided for coffee cans, screw-type bottle caps, and pressure lid jars.

12. Ease of disposal — Disposal is made easier if packages can be burned, crushed, or ground up. Burning must not produce toxic or otherwise noxious fumes to pollute the air. Some rigid plastic materials may be ruled out in the future because of disposal difficulties.

13. Size, shape, weight limitations — Lightweight packages are generally more economical as long as they give adequate protection. Size and shape are usually merchandising decisions. Supermarket managers and consumers generally favor square containers because of space considerations.

14. Appearance, printability — These are merchandising concerns, to be considered after all other criteria are met.

15. Low cost — This is a merchandising concern, to be considered after all other criteria are met.

16. Special Features — These are merchandising concerns, to be considered after all other criteria are met.

INFORMATION SHEET #3

Types of Containers

1. Primary and secondary — A primary container is one that comes in direct contact with the food, for example, a can or a jar. A secondary container is an outer box, case, or wrapper that may hold cans or jars but does not come in direct contact with the food.

2. Rigid versus flexible — Containers can be constructed from fully rigid through fully flexible. Examples include plastic milk jugs; squeeze bottles of mustard, sauces, and ketchup; and toothpaste-type tubes. The many types and thicknesses of food packaging plastics are particularly versatile in providing controllable rigidity for many different food applications.

3. Preformed and in-line forming — Containers may be preformed or fabricated at the factory, or may be in-line formed by assembly from roll stock or flat blanks just ahead of the filling operation.

4. Hermetic closure — A hermetically closed container is one that is absolutely impermeable to gases and vapors. This container, as long as it stays intact, will also be impervious to bacteria, yeasts, molds, and dirt from dust and other sources. Hermetic closure is essential when strict vacuum and pressure packaging is needed. Most common hermetic containers are rigid metal cans and glass containers.

INFORMATION SHEET #4

Laminated Packaging Materials

Lamination is used to produce some of the most sophisticated packaging materials.

The era of laminated packaging materials began with the advent of plastics-packaging technology.

Typical laminates include combinations of easily printable, but water-permeable and heat-unsealable cellophane with other plastics; two or more flexible films with differential gas permeabilities, and mechanical or other properties; and many multicomponent laminates of plastics with paper or metal foil.

The plastic-paper combination is advantageous for fluid food packaging since the sturdiness, printability, and low cost of the paper carton is combined with the heat-sealability and water-resistance of the plastic.

Some complicated laminates are used for packaging of UHT (Ultra High Temperature) sterilized food products.

Retortable pouches, UHT processing of liquid foods, and "shrink-wrapping" technology are all based on development of lamination technology.

INFORMATION SHEET #5

Effects of Food Packaging on Food Stability

Foods sensitive to oxidative fat deterioration (rancidity) may have to be packaged in a vacuum or an inert atmosphere. The packaging material must be impermeable to oxygen as well as to inert gas.

Dried foods must be packaged in containers resistant to liquid water and water vapor. Water absorption could cause deterioration due to microbial growth.

Packaging must be selected for foods containing light-sensitive components. Examples of such components include riboflavin in milk, flavor compounds in beer, vitamin C in potato chips, etc.

Plastic materials for fresh meats should have high permeability for oxygen, allowing oxygenation of myoglobin for desired bright red color, but low water vapor permeability to avoid loss of water through evaporation.

Differential permeability for CO_2 and O_2 may be needed for fresh fruit and vegetable packaging to allow respiration requirements.

Packaging systems used for sterile foods must be effective in providing an airtight closure to eliminate microbial or other contamination from the surroundings.

A promising technique for sterilization of food products is radiation. In medicine, nearly 50 percent of all disposable instruments and other materials are now radiation sterilized.

The achievement of high sanitation by the food processing industry of today is facilitated by gradual replacement of packaging systems with potential contamination risks by sterile or near-sterile flexible films.

INFORMATION SHEET #6

Modified Atmosphere Packaging

The use of an enriched atmosphere of CO_2 gas for bakery and other fresh foods is a relatively new packaging concept whose potential has not been fully explored.

Nonrefrigerated shelf life of bakery products and certain other fresh foods can be extended by packaging these products in an atmosphere rich in CO_2 gas. The CO_2 atmosphere in packages of fresh products retards microbial growth substantially.

Other fresh foods for which CO_2 atmosphere packing has been used include cheese, cooked meats, bacon, and other products with a potential for mold growth.

Use of CO_2 is not suitable for fresh meats where anaerobic atmosphere created by replacing O_2 by CO_2 would result in formation of brown metmyoglobin pigment. It is also not suitable for fruits and vegetables which require a careful CO_2 concentration control.

INFORMATION SHEET #7

Role of Packaging in the Food Distribution Chain

Many of the most common foods could not be manufactured if proper packaging technology was not available.

Our lifestyle would be threatened if we had to spend a significant portion of our time and/or money shopping daily for perishable foods.

Many foods would be highly seasonal.

Contamination by insects, microorganisms, or environmental pollutants could result in nutrient losses and health hazards as experienced in the past.

A whole new system of food delivery from the producer to consumer has evolved with the concept of portion-packing. Virtually all our foods are now packaged, sometimes to the point of overpackaging.

From a safety point of view, consumers are much better off with overpackaged rather than underpackaged. The relative costs of food packages are many times substantiated when compared with the value of the foods contained in them.

In the United States we can buy the most varied, nutritious, safe, and enjoyable food at lower cost than anywhere else in the world.

TRANSPARENCY MASTER #1

Purpose of Food Packaging

1. Protection

2. Information and Content Identification and Marketing Tool

3. Integral Part of Food Processing Technology

4. Convenience Tool or Serving Utensil

TRANSPARENCY MASTER #2

Requirements and Functions of Containers

The following are among the more important general requirements and functions of food containers:

1. Nontoxic and Compatible with the Specific Food
2. Sanitary Protection
3. Moisture and Fat Protection
4. Gas and Odor Protection
5. Light Protection
6. Resistance to Impact
7. Transparency
8. Tamper-Resistant or Tamper-Evident

Requirements and Functions of Containers (cont'd.)

9. Ease of Opening
10. Pouring Features
11. Reseal Features
12. Ease of Disposal
13. Size, Shape, Weight Limitations
14. Appearance, Printability
15. Low Cost
16. Special Features

TRANSPARENCY MASTER #3

Functions of Packaging Materials

Function	*Specific Factors*
Permeable to gas	Vapors from O_2, CO_2, N_2, H_2O
Environmental protection	Light, odors, bacteria, moisture
Physical properties	Weight, elasticity, ability to be sealed by various means
Reactivity with organic compounds	Grease, acid, water, color
Properties related to marketability	Appearance, acceptance of print, cost
Convenience to user	Disposability, repeated use, secondary uses

TRANSPARENCY MASTER #4

Types of Containers

1. Primary and Secondary

2. Rigid versus Flexible

3. Preformed and In-line Forming

4. Hermetic Closure

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TRANSPARENCY MASTER #6

Papers Used as a Packaging Material

Type	*Example*	*Characteristics*
Kraft paper	Shopping bags	Brown, unbleached paper
Bleached paper	Bags and wrapping paper	White paper, may be glossy
Grease-proof paper	Meat product wrapping	Very smooth surface
Parchment	Butter wrapping	Semiclear paper treated with sulfuric acid to gelatinize surface layers
Glassine	Candy box wrappers	Clear, brittle
Paperboard, cardboard	Milk cartons, fresh meat and vegetable trays	Compacted paper pulp
Corrugated cardboard	Secondary boxes	Two paperboard sheets overlaying paper corrugations

Plastic Films Used in Food Packaging

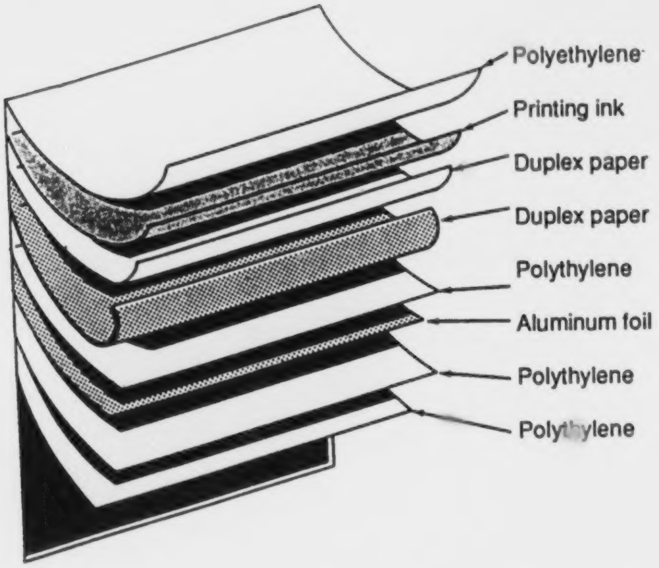
Common Name	*Chemical Name*	*Basic Compound*	*Important Properties*
Cellophane	Cellulose	Glucose	Reasonable strength, poor vapor barrier, accepts print, no heat sealability
Polyethylene	Polyethylene	Ethylene	Good heat sealability, excellent H_2O barrier, does not accept print
Saran	Polyvinyledene-vinyl-chloride	Vinyl	Oxygen and moisture barrier, fragile, heat sealable
Mylar	Polyester	Ethylene glycol + terephtalic acid	Excellent physical properties, poor heat sealability, fair vapor barrier
Nylon	Polyamide	Diamine + various acids	Excellent workability, reasonable strength, poor vapor barrier, heat sealable

TRANSPARENCY MASTER #8

Construction of the Laminated Packaging Material Used by Tetra-brik Aseptic Machinery

(Courtesy of Tetra-pak of Canada, Inc.)

Tetra Brik Aseptic, layers of material, starting from outside.


Polyethylene
Printing ink
Duplex paper
Duplex paper
Polythylene
Aluminum foil
Polythylene
Polythylene

1, 5, 7, and 8. Polyethylene

2. Printing ink

3-4. Duplex paper

6. Aluminum foil

STUDENT ACTIVITIES

STUDENT WORKSHEET #1 — Properties of an Ideal Food Container Word Search (with solution)

STUDENT WORKSHEET #2 — Materials Used for Food Packaging

For additional activities, teachers may refer to the "Suggested Teaching Activities and Procedures" section in the Instructor's Guide.

STUDENT WORKSHEET #1

Properties of an Ideal Food Container Word Search

G	Q	Y	C	K	I	P	P	L	Y	B	V	V	Y	K	W	P	T	E	N
G	X	X	B	J	T	K	A	A	C	I	O	Y	L	O	M	N	T	O	Z
F	F	J	Z	H	S	M	S	F	M	Y	U	I	X	X	A	R	N	N	Z
X	O	U	G	L	R	Q	O	A	X	H	G	C	A	T	A	T	V	C	R
Q	K	I	Z	E	T	P	G	C	L	H	W	G	S	N	O	C	L	D	B
E	L	Y	H	F	E	N	M	A	T	H	I	I	S	X	U	O	P	U	C
Q	L	T	S	N	O	Q	G	W	S	M	S	P	I	F	S	W	U	C	C
D	H	B	E	M	I	O	E	H	P	E	A	C	C	E	B	V	S	Q	M
E	E	D	A	A	E	I	R	E	R	R	S	N	D	N	C	L	K	B	C
T	S	L	T	S	G	L	R	P	E	P	R	O	T	E	C	T	I	V	E
N	M	K	B	H	O	M	A	N	R	G	Z	N	K	F	Q	G	L	V	C
I	I	S	T	I	E	P	T	B	A	E	O	T	J	O	J	U	E	Q	A
R	S	G	A	A	T	C	S	S	E	D	P	E	K	Y	T	T	J	B	B
P	L	B	B	N	W	A	V	I	O	L	Q	M	A	G	O	M	U	R	S
B	G	L	T	C	I	Y	P	R	D	P	E	E	A	S	Y	L	H	R	D
A	E	Y	U	F	J	T	S	M	D	R	M	D	D	T	Y	M	B	O	K
N	B	I	B	I	L	C	A	Y	O	G	F	L	E	Y	F	I	O	F	B
L	G	V	L	C	H	B	V	R	S	C	G	W	Q	W	D	F	M	D	S
X	M	O	G	G	Z	W	I	A	Y	T	O	L	N	E	R	E	H	Y	D
O	B	H	L	A	X	H	H	E	Q	P	V	K	T	H	Y	W	D	Z	T

The following words are hidden in the puzzle:

Closed
Compatible
Disposable
Easy
Food
Gases
Impermeable
Labeled
Light
Lightweight

Nontoxic
Odors
Opened
Printed
Protective
Resistant
Sanitary
Tamper-proof
Thermal
Transparent

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STUDENT WORKSHEET #1 — Key

Properties of an Ideal Food Container Word Search

• • • • • • • • L • • • • • • • • T • N

• • • • • T • A • • • • • L • • N T O •

• • • • H • M • • • • • I • • A R N • •

• • • G • R • O • • • G • • T A T • C •

• • I • E • P G • • H • • S N O • L • •

E L • H F E • • A T • I I S X • O • • •

• L T • N O • • W S M S P I • S • • • •

D • B E • • O E • P E A C • E • • • • •

E E D A • • I R E R R S • D • • • • • •

T • L • S G L R P E P R O T E C T I V E

N • • B H O M A N R • • • • • • • • • •

I • S T I E P T B • E O • • • • • • • •

R • • A A T • S • E D P E • • • • • • •

P • • B N • A • I O L • M A • • • • • •

• • L • • I • P R D • E • A S • • • • D

• E • • • • T S M • • • D • T Y • • O •

• • • • • • • A • O • • • • • • • O • •

• • • • • • • • R • C • • • • • F • • •

• • • • • • • • • Y • • • • • • • • • •

• • • • • • • • • • • • • • • • • • • •

The following words are hidden in the puzzle:

Closed
Compatible
Disposable
Easy
Food
Gases
Impermeable
Labeled
Light
Lightweight

Nontoxic
Odors
Opened
Printed
Protective
Resistant
Sanitary
Tamper-proof
Thermal
Transparent

STUDENT WORKSHEET #2

Materials Used for Food Packaging

Match the materials used for food packaging with the correct use of the material.

1. __________ Paper
2. __________ Glass
3. __________ Metal
4. __________ Plastics
5. __________ Laminates
6. __________ Wood
7. __________ Cloth
8. __________ Wax
9. __________ Edible Containers

A. Ice cream cones
B. Coating of fruits
C. Sacks
D. Bags
E. Bottles
F. Cans
G. Overwraps
H. Cartons for liquids
I. Crates
J. Jars
K. Coating of some cheeses
L. Pallets
M. Aluminum Foil
N. Cabbage Leaves
O. Cartons
P. Boxes
Q. Multilayered Plastics
R. Coating of vegetables

STUDENT WORKSHEET #2 — Key

Materials Used for Food Packaging

Match the materials used for food packaging with the correct use of the material.

1. *D, O, P* Paper
2. *E, J* Glass
3. *F, M* Metal
4. *G, E* Plastics
5. *H, Q* Laminates
6. *I, L* Wood
7. *C* Cloth
8. *B, K, R* Wax
9. *A, N* Edible Containers

A. Ice cream cones
B. Coating of fruits
C. Sacks
D. Bags
E. Bottles
F. Cans
G. Overwraps
H. Cartons for liquids
I. Crates
J. Jars
K. Coating of some cheeses
L. Pallets
M. Aluminum Foil
N. Cabbage Leaves
O. Cartons
P. Boxes
Q. Multilayered Plastics
R. Coating of vegetables

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Food Science and Technology

PROBLEM AREA: Identifying Career Opportunities in Food Science

RELATED PROBLEMS AREA(S):

1. Identifying Careers in Agriculture/Horticulture (Central Core Cluster)
2. Gaining Employment in an Agricultural Occupation (Central Core Cluster)
3. Identifying Career Opportunities in Agribusiness Management
4. Identifying Career Opportunities in Animal Science
5. Identifying Career Opportunities in Plant and Soil Science
6. Identifying Career Opportunities in Agricultural Engineering/Mechanization

PREREQUISITE PROBLEM AREA(S):

1. Identifying Careers in Agriculture/Horticulture (Central Core Cluster)

LEVEL: Preparatory

OCCUPATIONAL TASKS ADDRESSED:

STATE GOALS FOR LEARNING:

In planning the instruction for this problem area, teachers can promote the development of several student learning objectives which are related to the State Goals for Learning in Sciences and Social Sciences. These objectives are listed on the Learning Assessment Plan forms included on the following page(s). Those learning objectives marked with an asterisk (*) are taken from the sample lists provided by the Illinois State Board of Education.

Illinois Agricultural Core Curriculum
Agricultural Education 124 Mumford Hall 1301 W. Gregory Drive University of Illinois Urbana, IL 61801

Director: Dale A. Law, Ed.D.
Principal Investigator: Jerry D. Pepple, Ed.D.
Research Assistant: Randy J. Bernhardt

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ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date ____________
☐ Original submission ☐ Revision
Page ____ of ____

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☒ Sciences ☐ Physical Development/Health

(Affix label or complete district information.)
COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐
District Name
City

Contact Person: ____________
Title: ____________
Phone: (   )

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will have a working knowledge of the social and environmental implications and limitations of technological development.

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Identify careers in which scientific training is important.					
*2. Identify future vocations in science.					
3. Identify examples of Illinois' industries that use food science technology.					
4. Identify career opportunities within the food science industry.					
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Agricultural Business and Management
Food Science and Technology

Identifying Career Opportunities in Food Science

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date ____________
☐ Original submission ☐ Revision
Page ____ of ____

(Affix label or complete district information.)

COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐

District Name

City

Contact Person: ____________
Title: ____________
Phone: (   )

I. LEARNING AREA *(check one)*

☐ Language Arts
☐ Mathematics
☐ Sciences
☐ Fine Arts
☒ Social Sciences
☐ Physical Development/Health

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to apply the skills and knowledge gained in the social sciences to decision making in life situations.

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Understand the education and training required to prepare youth and adults for work.					
2. Describe the occupational characteristics of selected food science careers.					
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					1451

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INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Food Science and Technology

PROBLEM AREA: Identifying Career Opportunities in Food Science

STUDENT LEARNING OBJECTIVES

Upon completion of their study of this problem area, student will be able to:

1. Identify examples of Illinois' industries that use food science technology.
2. Identify career opportunities within the food science industry.
3. Describe the occupational characteristics of selected food science careers.

INSTRUCTOR'S NOTES AND REFERENCES

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INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Food Science and Technology

PROBLEM AREA: Identifying Career Opportunities in Food Science

PROBLEMS AND QUESTIONS FOR STUDY	INSTRUCTOR'S NOTES AND REFERENCES
1. What is food science?	
2. What are some of the careers in the field of food science?	
3. Can you describe what their job duties entail?	
4. Why is the field of food science important?	
5. What are the opportunities for employment in food science?	
6. How does one prepare for a career in food science technology?	
7. Select a specific career in food science. What are the educational requirements? What are the prospects for future employment? What are the duties of the job? What are the working conditions? What is the pay range?	

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Food Science and Technology

PROBLEM AREA: Identifying Career Opportunities in Food Science

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES

1. Begin the problem area with an interest approach which includes an overview of what is to be studied.

2. Define food science. Refer to Information Sheet #1.

3. List careers in the field of Food Science on the board. Have students explain what are the duties of these careers.

4. Information Sheet #3 is a listing of universities that may offer degrees in food science and could also provide information on the various careers in food science.

5. Have students complete Student Worksheet #1.

6. Have students complete Student Worksheet #2.

7. Ask students, "Why is the field of food science important?" Use this question to lead into a discussion of the importance of food science.

8. Invite individuals that work in the field of food science to the class as guest speakers. Possible resource people include food scientists working in industry and university food science professors.

9. Discuss with the class the job opportunities available in the field of food science.

10. Discuss with students the education and preparation necessary for a career in food science.

11. Have students conduct a research on a specific career in food science. Their research should answer the following questions:
    1. What are the educational requirements?
    2. What are the prospects for future employment?
    3. What are the duties of the job?
    4. What are the working conditions?
    5. What is the pay range?

12. Sources of reference materials could include (1) local or school library, (2) colleges or universities, (3) magazines, books, etc., (4) guidance counselor(s), and (5) college or university course catalogs or degree program catalogs. The students' findings could be put together into a standard research paper, a career poster, or a career "brochure."

INSTRUCTOR'S NOTES AND REFERENCES

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INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Food Science and Technology

PROBLEM AREA: Identifying Career Opportunities in Food Science

REFERENCES

*1. *Food Science.* (1986). Potter, Norman N. 4th Edition. AVI Publishing Company, Inc., 250 Post Road East, P.O. Box 831, Westport, CT 06881.

*2. *Introduction to Food Processing.* (1985). Jelen, Pavel. Reston Publishing Company, Inc., A Prentice-Hall Company, Reston, VA 22090.

3. *Employment Opportunities for College Graduates in the Food and Agricultural Sciences.* (July 1986). Associate Dean, College of Agriculture, Texas A & M University, College Station, TX 77843.

4. For further information about careers in Food Science and Technology, contact:

*The Institute of Food Technologists
221 North LaSalle Street
Chicago, IL 60601
(312) 782-8424

*Indicates highly recommended reference

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTIONAL RESOURCES

These resources are intended for use by teachers in planning and teaching the materials for this problem area and may be adapted to fit the teaching methods(s) used.

INFORMATION SHEET #1 — What is Food Science?

INFORMATION SHEET #2 — Careers and Career Duties in the Field of Food Science

INFORMATION SHEET #3 — Universities and Colleges in the United States

INFORMATION SHEET #4 — Why is the Field of Food Science Important?

INFORMATION SHEET #5 — Preparing for a Career in Food Science and Technology

TRANSPARENCY MASTER #1 — Careers in the Field of Food Science

TRANSPARENCY MASTER #2 — Scientists, Engineers, and Related Specialists (with discussion guide)

TRANSPARENCY MASTER #3 — Marketing, Merchandising, and Sales Representatives (with discussion guide)

TRANSPARENCY MASTER #4 — Social Services Professionals (with discussion guide)

INFORMATION SHEET #1

What is Food Science?

Food Science/Technology is a diverse discipline that has been broadly defined as the application of science and engineering to the production, processing, distribution, preparation, evaluation, and utilization of food. The work of food technology begins with the raw agricultural products and primarily involves the processing and preservation of commercial food products. Food scientists include chemists, microbiologists, engineers, research specialists, quality control specialists, and others.

There are three general areas of common misunderstanding about the field of food science. First, many young people confuse food science with cooking, i.e., with food preparation in a restaurant. But the training and education of cooks and chefs is entirely different from food science.

Others confuse food technology with nutrition and dietetics. Nutritionists and dieticians determine how much and what kinds of foods and nutritional elements we should have. The food scientist uses this information in designing food preparation processes to ensure that these needs are met in commercially available foods, including special dietary foods.

The third area of misunderstanding is the confusion between food science and home economics, which stems from the fact that many home economics curricula offer some course work in food science, food chemistry, and/or experimental foods. The main emphasis of home economics, however, is on food preparation in the home and in institutional situations, such as hospitals and schools.

Adapted from *Food Science Experiments.* Institute of Food Technologists, 221 North LaSalle Street, Suite 300, Chicago, IL 60601 (312) 782-8424. (Introduction) Single copies, along with a Teacher's Guide, of the complete booklet can be obtained at no charge.

INFORMATION SHEET #2

Careers and Career Duties in the Field of Food Science

1. Overall Definition for Food Science Careers:
    a. Food technologists — those who study the scientific properties of food and develop methods for its safe processing, preservation, packaging, storage, and transportation. Many are specialists that concentrate on one type of food or one technical process.
2. Specific careers:
    a. Food chemist — studies the basic composition, structure, and properties of foods and the chemical changes occurring during processing and utilization.
    b. Food analyst — deals with the principles, methods, and techniques necessary for quantitative physical and chemical analyses of food and food products The analyses will be related to standards and regulations for food processing.
    c. Food microbiologist — studies the relationship of habitat to occurrence of microorganisms of foods; the effect of environment on growth of various microorganisms in food; the microbiology of food spoilage and food manufacture; the physical, chemical, and biological destruction of microorganisms in foods; the microbiological examination of foodstuffs; and public health and sanitation bacteriology.
    d. Food science engineer — is involved with the study of engineering concepts and the development of unit operations used in food processing. Engineering principles include mechanics, fluid mechanics, transfer and rate processes, and process control instrumentation.
    e. Food processor — deals with the general characteristics of raw food material; harvesting, assembling, and receiving raw materials; methods of food preservation; processing, including factors influencing food acceptability and preferences; packaging; water and waste disposal; and sanitation.
    f. Quality control manager/specialist — continuously monitors the required parameters of incoming raw materials and finished food products.
    g. Manager/specialist/scientist — studies ways to develop new or improve current products or processes, methodologies, or laboratory procedures.

INFORMATION SHEET #3

Universities and Colleges in the United States

Alabama
Alabama A&M University
Normal, AL 35762

Auburn University
Auburn, AL 36849

Tuskegee Institute
Tuskegee Institute, AL 36088

Alaska
University of Alaska
Agricultural Experiment Station
Palmer, AK 99645

Arizona
The University of Arizona
Tucson, AZ 85721

Arizona State University
Tempe, AZ 85281

Arkansas
Southern Arkansas University
Magnolia, AR 71753

University of Arkansas
Fayetteville, AR 72701

University of Arkansas
Monticello, AR 71655

University of Arkansas
Pine Bluff, AR 71601

California
California Polytechnic State Univ.
San Luis Obispo, CA 93407

California State Polytechnic Univ.
Pomona, CA 91768

California State University
Chico, CA 95926

California State University
Fresno, CA 93740

Humboldt State University
Arcata, CA 95521

University of California
Davis, CA 95616

University of California
Riverside, CA 92521

Colorado
Colorado State University
Fort Collins, CO 80523

Fort Lewis College
Durango, CO 81301

Connecticut
The University of Connecticut
Storrs, CT 06268

Delaware
Delaware State College
Dover, DE 19901

University of Delaware
Newark, DE 19711

Florida
Florida Southern College
Lakeland, FL 33801

University of Florida
Gainesville, FL 32611

Georgia
Abraham Baldwin Agric. College
Tifton, GA 31794

Berry College
Mount Berry, GA 30149

Fort Valley State College
Fort Valley, GA 31030

University of Georgia
Athens, GA 30602

Hawaii
University of Hawaii
Honolulu, HI 96822

Idaho
College of South Idaho
Twin Falls, ID 83301

Ricks College
Rexburg, ID 83440

University of Idaho
Moscow, ID 83843

Illinois
Illinois State University
Normal, IL 61761

Southern Illinois University
Carbondale, IL 62901

University of Illinois
Urbana, IL 61801

Western Illinois University
Macomb, IL 61455

Indiana
Purdue University
West Lafayette, IN 47907

Iowa
Iowa State University
Ames, IA 50011

Kansas
Fort Hays State University
Hays, KS 67601

Kansas State University
Manhattan, KS 66506

McPherson College
McPherson, KS 67460

Kentucky
Morehead State University
Morehead, KY 40351

Murray State University
Murray, KY 42071

University of Kentucky
Lexington, KY 40506

Western Kentucky University
Bowling Green, KY 42101

Louisiana
Louisiana State University
Baton Rouge, LA 70803

Louisiana Tech University
Ruston, LA 71272

McNeese State University
Lake Charles, LA 70609

Universities and Colleges in the United States (con't.)

Nicholls State University
Thibodaux, LA 70310

Northeast Louisiana University
Monroe, LA 71209

Northwestern State University
Natchitoches, LA 71497

Southeastern Louisiana University
Hammond, LA 70402

Southern University
Baton Rouge, LA 70813

University of Southwestern Louisiana
Lafayette, LA 70504

Maine
University of Maine
Orono, ME 04469

Maryland
University of Maryland
College Park, MD 20742

University of Maryland
Princess Anne, MD 21853

Massachusetts
University of Massachusetts
Amherst, MA 01003

Michigan
Michigan State University
East Lansing, MI 48824

Michigan Technological University
Hancock, MI 49930

Northern Michigan University
Marquette, MI 49855

Minnesota
University of Minnesota
St. Paul, MN 55108

Univ. of Minnesota Technical College
Crookston, MN 56716

Univ. of Minnesota Technical College
Waseca, MN 56093

Mississippi
Alcorn State University
Lorman, MS 39096

Mississippi State University
Mississippi State, MS 39762

Missouri
Central Missouri State University
Warrensburg, MO 64093

Lincoln University
Jefferson City, MO 65101

Missouri Western State College
St. Joseph, MO 64507

Northeast Missouri State University
Kirksville, MO 63501

Northeast Missouri State University
Maryville, MO 64468

Southwest Missouri State University
Springfield, MO 65802

University of Missouri
Columbia, MO 65211

Montana
Montana State University
Bozeman, MT 59717

Northern Montana College
Havre, MT 59501

Nebraska
University of Nebraska
Lincoln, NE 68583

Nevada
University of Nevada
Reno, NV 89557

New Hampshire
University of New Hampshire
Durham, NH 03824

New Jersey
Rutgers University
New Brunswick, NJ 08903

New Mexico
New Mexico State University
Las Cruces, NM 88003

New York
Cornell University
Ithaca, NY 14853

North Carolina
North Carolina A&T State University
Greensboro, NC 27411

North Carolina State University
Raleigh, NC 27650

North Dakota
North Dakota State University
Fargo, ND 58105

Ohio
The Ohio State University
Columbus, OH 43210

Wilmington College
Wilmington, OH 45177

Oklahoma
Cameron University
Lawton, OK 73505

Langston University
Langston, OK 73050

Oklahoma Panhandle State University
Goodwell, OK 73939

Oklahoma State University
Stillwater, OK 74074

Oregon
Oregon State University
Corvallis, OR 97331

Pennsylvania
Delaware Valley College of Science
and Agriculture
Doylestown, PA 18901

The Pennsylvania State University
University Park, PA 16802

Universities and Colleges in the United States (con't)

Temple University
Ambler, PA 19002

Puerto Rico
University of Puerto Rico
Mayaguez, PR 00708

University of Puerto Rico
Rio Piedras, PR 00928

Rhode Island
University of Rhode Island
Kingston, RI 02881

South Carolina
Clemson University
Clemson, SC 29631

South Dakota
South Dakota State University
Brookings, SD 57007

Tennessee
Austin Peay State University
Clarksville, TN 37040

Middle Tennessee State University
Murfreesboro, TN 37130

Tennessee Technological University
Cookeville, TN 38505

University of Tennessee
Knoxville, TN 37901

University of Tennessee
Martin, TN 38238

Texas
Abilene Christian University
Abilene, TX 79601

East Texas State University
Commerce, TX 75428

Prairie View A&M University
Prairie View, TX 77445

Sam Houston State University
Huntsville, TX 77341

Southwest Texas State University
San Marcos, TX 78666

Stephen F. Austin State University
Nacogdoches, TX 75962

Texas A&I University
Kingsville, TX 78363

Texas A&M University
College Station, TX 77843

Texas Tech University
Lubbock, TX 79409

West Texas State University
Canyon, TX 79015

Utah
Brigham Young University
Provo, UT 84602

Utah State University
Logan, UT 84322

Vermont
University of Vermont
Burlington, VT 05405

Virginia
Old Dominion University
Norfolk, VA 23508

Virginia Polytechnic Institute and State University
Blacksburg, VA 24061

Virginia State College
Petersburg, VA 23806

Washington
University of Washington
Seattle, WA 98195

Washington State University
Pullman, WA 99164

West Virginia
West Virginia University
Morgantown, WV 26506

Wisconsin
University of Wisconsin
Green Bay, WI 54302

University of Wisconsin
Madison, WI 53706

University of Wisconsin
Platteville, WI 53818

University of Wisconsin
River Falls, WI 54022

University of Wisconsin
Stevens Point, WI 54481

Wyoming
University of Wyoming
Laramie, WY 82071

Reprinted from *Exploring Careers in Agronomy, Crops, and Soils*. American Society of Agronomy, 677 South Segoe Road, Madison, WI 53711 (608) 273-8080.

INFORMATION SHEET #4

Why is the Field of Food Science Important?

It has been estimated that nearly two billion people do not have enough to eat and that perhaps as many as 10,000 die every day for either the lack of enough food or the lack of sufficient protein and other specific nutrients. Many food scientists are engaged in developing palatable, nutritious, low-cost foods.

Food scientists have helped develop food products for space travelers. Many of these developments have had an effect on the foods we eat today as well.

Food scientists have been active in developing products suitable for feeding military personnel.

Food science is involved in the making of foods that look and taste like meat but are made from vegetable proteins.

The application of food preservation methods helps prevent outbreaks of food poisoning. The food industry today has a superior record of preventing such mishaps considering that billions of cans, jars, and pouches of food materials are consumed annually.

INFORMATION SHEET #5

Preparing for a Career in Food Science and Technology

1. High School Education

   Course work at the high school level should prepare students for an extensive science-oriented college program and include courses in agricultural science, mathematics, chemistry, physics, biology, a foreign language, English, and social sciences.

2. College Education

   a. Core courses in Food Science and Technology should include:

      1) Food processing.
      2) Food chemistry.
      3) Food microbiology.
      4) Food analysis.
      5) Food engineering.

   b. Additional requirements for a Food Science degree may include:

      1) Two courses in chemistry and two courses in organic chemistry-biochemistry.
      2) One course in general biology and one in microbiology.
      3) One course in nutrition.
      4) Competency in algebra, trigonometry, and calculus. Computer science is recommended also.
      5) Competency in elementary statistics.
      6) One course in general physics.
      7) Competency in written and spoken English; usually minimum of two courses.
      8) Courses in humanities and social sciences.

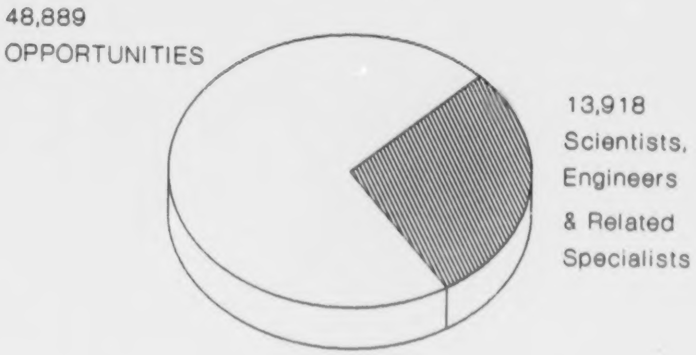
TRANSPARENCY MASTER #1

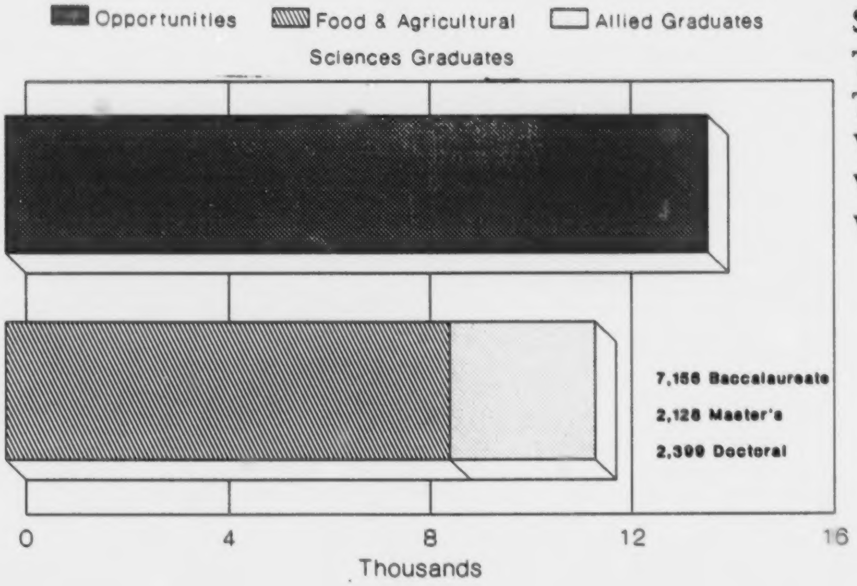
Careers in the Field of Food Science

1. Overall Definition of Food Science Careers
    a. Food Technologists
2. Specific Careers
    a. Food Chemist
    b. Food Analyst
    c. Food Microbiologist
    d. Food Science Engineer
    e. Food Processor
    f. Quality Control Manager/Specialist
    g. Product Development Manager/Specialist/ Scientist

TRANSPARENCY MASTER #2

Scientists, Engineers, and Related Specialists





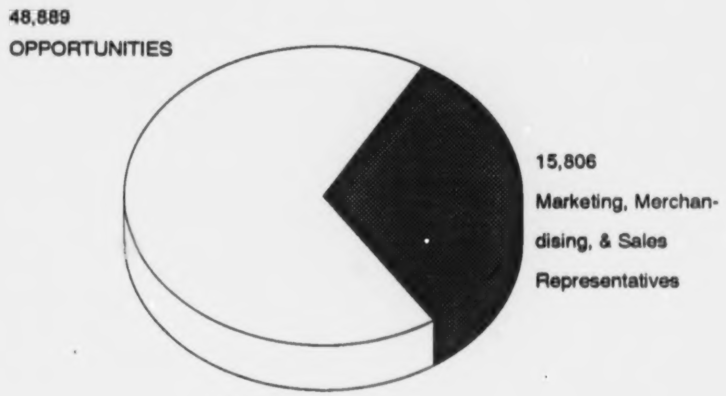
Examples

- Agricultural Engineer
- Animal Scientist
- Biochemist
- Biometrician
- Entomologist
- Environmental Engineer
- Food Engineer
- Food Scientist
- Forest Scientist
- Geneticist
- Landscape Architect
- Microbiologist
- Nutritionist
- Physiologist
- Plant Scientist
- Rangeland Scientist
- Safety Engineer
- Soil Scientist
- Technician
- Toxicologist
- Veterinarian
- Water Engineer
- Weed Scientist

Employment Opportunites for College Graduates in the Food and Agricultural Sciences. Texas A & M University, College of Agriculture, College Station, TX 77843-2142 (409) 845-3711. Source of this data is from a report conducted every five years. The next report is scheduled for 1991.

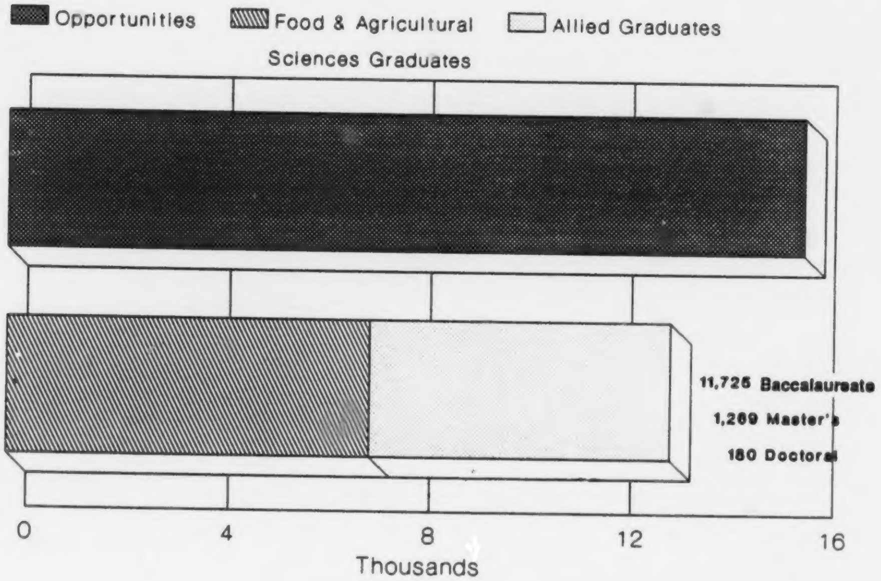
TRANSPARENCY MASTER #3

Marketing, Merchandising, and Sales Representatives



Examples

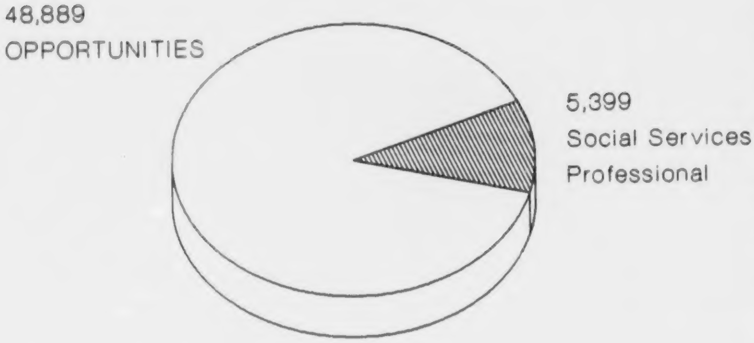
Commodity Broker
Food Broker
Grain Merchandiser
Insurance Agent
Livestock Buyer
Market Analyst
Marketing Manager
Sales Representative
Technical Service Representative
Timber Buyer



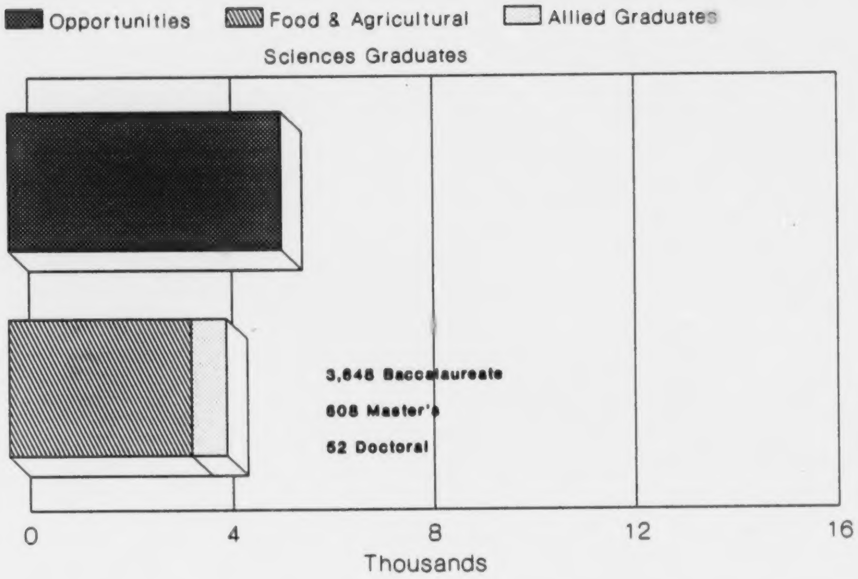
Employment Opportunites for College Graduates in the Food and Agricultural Sciences. Texas A & M University, College of Agriculture, College Station, TX 77843-2142 (409) 845-3711. Source of this data is from a report conducted every five years. The next report is scheduled for 1991.

TRANSPARENCY MASTER #4

Social Services Professionals



Examples
Career Counselor
Community Development Specialist
Dietitian
Food Inspector
Labor Relations Specialist
Park and Recreation Specialist
Naturalist
Nutrition Counselor
Regional Planner
Regulatory Agent



Employment Opportunites for College Graduates in the Food and Agricultural Sciences. Texas A & M University, College of Agriculture, College Station, TX 77843-2142 (409) 845-3711. Source of this data is from a report conducted every five years. The next report is scheduled for 1991.

TRANSPARENCY MASTER DISCUSSION GUIDES

Transparency Master #2

U.S. employment data indicate expanding career opportunities in science, engineering, and related professions for agriculture, natural resource, and veterinary medicine college graduates. These public and private sector professionals will play a critical role in carrying out essential research and development initiatives to enhance the competitive position of U.S. technology in the world market.

In the aggregate, almost 14,000 openings are projected annually in the United States through 1990. Slightly more than 11,600 qualified college graduates are anticipated per annum, leaving a projected annual deficit of more than 2,000 graduates for research, engineering, and technical positions.

The strongest employment opportunites will be for persons having doctoral degrees or postdoctoral experience in molecular genetics, biochemistry, food science, and soil science. Also, it is expected that approximately 2,000 new veterinarians will be employed during each of the next five years.

More than 800 scientifc and engineering openings are projected annually for foresters and natural resource conservationists, an increasing proportion of which are likely to be in the private sector. New employment opportunities for landscape architects are expected to exceed 500 each year.

During the late 1970s and early 1980s, fewer individuals enrolled in agricultural and life sciences programs at U.S. colleges and universities. This enrollment decline occurred during the advent of significant expansion of biotechnology research related to our nation's food system. Also, increasing research activity is emerging with regard to postharvest use of agricultural commodities and timber.

Throughout the remainder of the 1980s, more than one-fourth of new college graduates who will qualify for positions as food and agricultural scientists, engineers, and related specialists will earn degrees in allied fields closely related to natural resources, agriculture, and veterinary medicine. The principal complementary disciplines are expected to be chemical engineeinrg, civil engineering, and industrial engineering, along with selected biological science specialties such as microbiology, molecular genetics, biochemistry, physiology, and cell biology.

Slightly more than 6,000 of the 14,000 openings for scientists, engineers, and related specialists are of such a nature that master's or doctoral degrees will likely be required for entry level positions. On the other hand, only 4,500 qualified advanced degree recipients are projected to be available annually. Consequently, two-thirds of the total projected shortfall of food and agricultural scientists, engineers, and related specialists are in occupations likely to require graduates with advanced degrees.

Transparency Master #3

In 1984, U.S. consumers spent $332 billion for food produced by farmers. Of this total, some $242 billion were expended for processing, marketing, and other functions in the farmer-to-consumer food system. Also, farm supply and service industries added an estimated $178 billion to the U.S. gross national product and employed some 4.2 million people.

Economic activity of this magnitude requires a continuing extensive infusion of college-educated professionals. Projections indicate that through 1990, there will be more than 15,000 annual openings in sales, merchandising, and marketing for new graduates having food and agricultural expertise. Professional positions requiring such expertise include technical sales representatives, buyers, brokers, market analysts, and customer service represenatives.

Some 11,725 baccalaureate degree recipients will account for more than 85 percent of the new graduates who will be qualified each year for entry positions in food and agricultural marketing, merchandising, and sales. It is expected that slightly more than half of the qualified graduates will have specializations in closely allied programs such as business, economics, product management, and purchasing.

Fewer than 1,450 master's and doctoral degree recipients are estimated to be available to assume professional positions in food and agricultural marketing, merchandising, and sales each year through 1990. Principal employment opportunities for these individuals will be in purchasing and buying, market analysis, and technical sales, as well as international trade.

It is important to note that about one-third of all food and agricultural employment opportunities for college graduates througout the remainder of the decade will be in marketing, merchandising, and sales. The best qualified individuals will have strong academic credentials that reflect business and communication skills in addition to a technical understanding of food and fiber production and/or processing. Graduates also having specific preparation in sales techniques will likely receive the greatest attention from prospective employers.

Increased numbers of qualified baccalaureate and master's degree recipients will be needed to fill available positions in this employment area. During the next five years, the quantity of marketing, merchandising, and sales positions associated with postharvest food and fiber distribution will continue to expand. In contrast, a reduction in the number of similar positions in farm supply and service industries is anticipated.

At the doctoral level, a shortfall of food and agricultural graduates with expertise in international food marketing and trade exists. This condition is likely to worsen as U.S. companies continue to become multinational in scope.

Transparency Master #4

Like most other segments of the U.S. labor force, an increasing proportion of agricultural and natural resource professionals will be providing social services in the coming years. Dietitians are expected to account for more than 3,100 of the 5,399 projected annual openings for food and agricultural social services professionals through the remainder of the decade. Sound opportunites will exist for personnel and labor relations specialists, recreation workers, naturalists, regional planners, and community development specialists, as well as nutritionists and dietetic technicians.

Opportunities for dietitians and dietetic technicians will increase with the increase in the number of organizations that provide services to preschool children, senior citizens, and other segments of the population. Annual openings for dietitians in hospitals, schools, and residential care facilities are expected to grow proportionately to the numbers of citizens served by these institutions.

Annually, more than 4,300 qualified college graduates are expected to be available to accept professional social services positions. Enrollment patterns indicate that some 50 doctoral degree and 600 master's degree recipients will be available annually to compete for openings. However, some 85 percent of the available graduates will have only a baccalaureate degree.

College programs in the food and agricultural sciences are expected to produce some 2,975 social services professionals each year. Nearly half of these will be specialists in dietetics, human nutrition, and food science. Forestry and natural resource programs are projeted to contribute more than 600 graduates. Agricultural economics programs are expected to produce nearly 250 qualified graduates annually.

College degree programs in business, sociology, psychology, health sciences, and related areas are expected to contribute nearly 1,350 qualified graduates each year. However, fewer than 180 of these graduates will hold master's or doctoral degrees.

Steady expansion of social services opportunities is anticipated for consultants and with organizations which provide nutrition counseling. Growing evidence suggests that an increasing proportion of social services professionals will find employment in the private sector during the next five years.

Employment Opportunites for College Graduates in the Food and Agricultural Sciences. Texas A & M University, College of Agriculture, College Station, TX 77843-2142 (409) 845-3711. Source of this data is from a report conducted every five years. The next report is scheduled for 1991.

STUDENT ACTIVITIES

STUDENT WORKSHEET #1 — Careers and Career Duties in the Field of Food Science

STUDENT WORKSHEET #2 — Careers in Food Science and Technology Word Search (with solution)

For additional activities, teachers may refer to the "Suggested Teaching Activities and Procedures" section in the Instructor's Guide.

STUDENT WORKSHEET #1

Careers and Career Duties in the Field of Food Science

Match the Food Science career with its correct definition.

1. ______ Product Development Manager/Specialist/Scientist
2. ______ Food Technologists
3. ______ Food Chemist
4. ______ Food Microbiologist
5. ______ Quality Control Manager/Specialist
6. ______ Food Analyst
7. ______ Food Science Engineer
8. ______ Food Processor

A. Studies ways to develop new or improve current products or processes, methodologies, or laboratory procedures.

B. An overall definition for those who study the scientific properties of food and develop methods for its safe processing, preservation, packaging, storage, and transportation. Many are specialists that concentrate on one type of food or one technical process.

C. Monitors continuously the required parameters of incoming raw materials and finished food products.

D. Studies the basic composition, structure, and properties of foods and the chemical changes occurring during processing and utilization.

E. Deals with the general characteristics of raw food material; harvesting, assembling, and receiving raw materials; methods of food preservation; processing, including factors influencing food acceptability and preferences; packaging; water and waste disposal; and sanitation.

F. Deals with the principles, methods, and techniques necessary for quantitative physical and chemical analyses of food and food products. The analyses will be related to standards and regulations for food processing.

G. Is involved with the study of engineering concepts and the development of unit operations used in food processing. Engineering principles include mechanics, fluid mechanics, transfer and rate processes, and process control instrumentation.

H. Studies the relationship of habitat to occurrence of microorganisms of foods; the effect of environment on growth of various microorganisms in food; the microbiology of food spoilage and food manufacture; the physical, chemical, and biological destruction of microorganisms in foods; the microbiological examination of foodstuffs; and public health and sanitation bacteriology.

STUDENT WORKSHEET #1 — Key

Careers and Career Duties in the Field of Food Science

1. *A* Product Development Manager/Specialist/Scientist
2. *B* Food Technologists
3. *D* Food Chemist
4. *H* Food Microbiologist
5. *C* Quality Control Manager/Specialist
6. *F* Food Analyst
7. *G* Food Science Engineer
8. *E* Food Processor

A. Studies ways to develop new or improve current products or processes, methodologies, or laboratory procedures.

B. An overall definition for those who study the scientific properties of food and develop methods for its safe processing, preservation, packaging, storage, and transportation. Many are specialists that concentrate on one type of food or one technical process.

C. Monitors continuously the required parameters of incoming raw materials and finished food products.

D. Studies the basic composition, structure, and properties of foods and the chemical changes occurring during processing and utilization.

E. Deals with the general characteristics of raw food material; harvesting, assembling, and receiving raw materials; methods of food preservation; processing, including factors influencing food acceptability and preferences; packaging; water and waste disposal; and sanitation.

F. Deals with the principles, methods, and techniques necessary for quantitative physical and chemical analyses of food and food products. The analyses will be related to standards and regulations for food processing.

G. Is involved with the study of engineering concepts and the development of unit operations used in food processing. Engineering principles include mechanics, fluid mechanics, transfer and rate processes, and process control instrumentation.

H. Studies the relationship of habitat to occurrence of microorganisms of foods; the effect of environment on growth of various microorganisms in food; the microbiology of food spoilage and food manufacture; the physical, chemical, and biological destruction of microorganisms in foods; the microbiological examination of foodstuffs; and public health and sanitation bacteriology.

STUDENT WORKSHEET #2

Careers in Food Science and Technology Word Search

R	E	H	G	N	I	R	E	E	N	I	G	N	E	Y	M	D	E	O	B
H	L	A	X	P	R	O	C	E	S	S	I	N	G	I	H	H	C	E	Q
P	V	B	Y	G	O	L	O	N	H	C	E	T	C	K	T	T	N	H	Y
W	D	I	Z	T	Y	I	G	P	P	F	B	R	I	Y	E	E	E	W	W
V	J	O	B	E	J	P	T	C	U	D	O	R	P	Z	C	O	I	E	Q
M	L	C	C	T	O	I	F	C	J	B	R	O	G	B	H	P	C	G	V
M	T	H	O	U	W	Y	B	X	I	H	H	D	D	L	N	N	S	E	D
Y	Y	E	V	P	Y	Z	L	O	E	C	L	U	O	M	O	E	B	L	U
T	A	M	C	S	P	T	L	D	U	C	H	R	X	U	L	X	F	L	P
I	Z	I	V	I	E	O	U	Z	T	B	T	E	B	T	O	D	G	O	Y
L	X	S	Q	G	G	C	R	S	H	N	D	P	M	E	G	Y	P	C	F
A	S	T	L	Y	A	B	K	T	O	U	E	M	C	I	I	Z	F	W	G
U	V	R	S	T	J	X	N	C	U	X	A	M	H	E	S	H	K	T	D
Q	G	Y	I	E	W	P	T	I	O	N	N	N	P	I	T	T	U	Y	I
J	Q	O	Y	Z	L	I	E	Q	W	M	I	X	A	O	S	F	R	D	R
A	N	A	L	Y	S	I	S	K	R	E	Q	T	P	L	L	B	H	Y	P
V	C	A	R	E	E	R	S	D	V	Y	A	B	I	T	Y	E	D	V	P
P	V	L	B	S	G	F	C	T	U	W	K	G	C	E	T	S	V	R	T
X	N	S	P	E	C	I	A	L	I	S	T	S	W	W	S	T	T	E	V
U	T	I	N	U	X	O	V	W	A	T	D	U	E	U	P	T	K	A	D

The following words are hidden in the puzzle:

Analysis
Analyst
Biochemistry
Careers
Chemistry
College
Control
Development
Education
Engineering

Food
Microbiology
Opportunities
Processing
Product
Quality
Science
Specialists
Technologists
Technology

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STUDENT WORKSHEET #2 — Key

Careers in Food Science and Technology Word Search

•	•	•	G	N	I	R	E	E	N	I	G	N	E	•	M	•	E	•	•
•	•	•	•	P	R	O	C	E	S	S	I	N	G	I	•	•	C	•	•
•	•	B	Y	G	O	L	O	N	H	C	E	T	C	•	T	•	N	•	•
•	•	I	•	•	•	•	•	•	•	F	•	R	•	•	E	•	E	•	•
•	•	O	•	•	•	•	T	C	U	D	O	R	P	•	C	•	I	E	•
•	•	C	•	•	•	•	•	•	•	B	•	O	•	•	H	•	C	G	•
•	•	H	O	•	•	•	•	•	I	•	•	•	D	L	N	•	S	E	•
Y	•	E	•	P	•	•	•	O	E	C	•	•	O	•	O	•	•	L	•
T	•	M	•	•	P	•	L	D	•	•	H	R	•	•	L	•	•	L	•
I	•	I	•	•	•	O	U	•	T	•	T	E	•	•	O	•	•	O	•
L	•	S	•	•	G	C	R	•	•	N	•	•	M	•	G	•	•	C	•
A	•	T	•	Y	A	•	•	T	O	•	E	•	•	I	I	•	•	•	•
U	•	R	•	T	•	•	•	C	U	•	A	M	•	•	S	•	•	•	•
Q	•	Y	I	•	•	•	•	•	•	N	•	N	P	•	T	T	•	•	•
•	•	O	•	•	•	•	•	•	•	•	I	•	A	O	S	•	R	•	•
A	N	A	L	Y	S	I	S	•	•	•	•	T	•	L	L	•	•	Y	•
•	C	A	R	E	E	R	S	•	•	•	•	•	I	•	Y	E	•	•	•
•	•	•	•	•	•	•	•	•	•	•	•	•	•	E	•	S	V	•	•
•	•	S	P	E	C	I	A	L	I	S	T	S	•	•	S	•	T	E	•
•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	D

The following words are hidden in the puzzle:

Analysis
Analyst
Biochemistry
Careers
Chemistry
College
Control
Development
Education
Engineering

Food
Microbiology
Opportunities
Processing
Product
Quality
Science
Specialists
Technologists
Technology

1474

UNIT E: Agricultural Engineering/Mechanization

PROBLEM AREAS:

1. Welding and Metalworking
2. Designing, Building, and Maintaining Agricultural Structures
3. Repairing and Maintaining Agricultural Equipment
4. Understanding and Maintaining Small Engines
5. Financing and Managing Agricultural Equipment
6. Manufacturing, Distributing, Selling, and Servicing Agricultural Equipment
7. Identifying Career Opportunities in Agricultural Engineering/Mechanization

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agricultural Engineering/Mechanization

PROBLEM AREA: Welding and Metalworking

RELATED PROBLEM AREAS:

1. Identifying Basic Agricultural Mechanics Principles (Central Core Cluster)
2. Repairing and Maintaining Agricultural Equipment (Central Core Cluster)
3. Developing Safe Work Habits in Agricultural Occupations (Central Core Cluster)

PREREQUISITE PROBLEM AREA(S): None

LEVEL: Preparatory

OCCUPATIONAL TASKS ADDRESSED:

Agricultural Business and Management Cluster

Duty I: Assembling, Servicing, and Maintaining Equipment and Facilities

1. Repair equipment utilizing shielded metal arc welding
2. Repair equipment utilizing oxy-fuel (OAW)
3. Cut and pierce metal utilizing OAW equipment
4. Cut and pierce metal utilizing SMAW equipment
5. Perform maintenance checks

Duty R: Applying Safety Practices

1. Comply with shop and equipment safety rules
2. Inspect work area and equipment for safe working environment

STATE GOALS FOR LEARNING

In planning the instruction for this problem area, teachers can promote the development of several student learning objectives which are related to the State Goals for Learning in Biological and Physical Sciences. These objectives are listed on the Learning Assessment Plan forms included on the following page(s). Those learning objectives marked with an asterisk (*) are taken from the sample lists provided by the Illinois State Board of Education.

Illinois Agricultural Core Curriculum

Agricultural Education 124 Mumford Hall 1301 W. Gregory Drive University of Illinois Urbana, IL 61801

Director: Dale A. Law, Ed.D.
Principal Investigator: Jerry D. Pepple, Ed.D.
Research Assistant: Douglas L. Stockley

1477

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date________________
☐ Original submission ☐ Revision
Page ____ of ____

(Affix label or complete district information.)
COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐
District Name
City

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☒ Sciences ☐ Physical Development/Health

II. STATE GOAL FOR LEARNING
As a result of their schooling, students will have a working knowledge of the concepts and basic vocabulary of biological, physical, and environmental sciences and their application to life and work in contemporary technological society.

Contact Person: ________________
Title: ________________
Phone: ( )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
1. Compare the phases of matter.					
2. Understand the effect of heat energy on matter.					
3. Classify samples of matter by their characteristic physical and chemical properties.					
4. Identify conductors and insulators.					

ISBE 41-78 (1/88)

Illinois Agricultural Core Curriculum Rev.

Welding and Metalworking

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date ____________
☐ Original submission ☐ Revision
Page ____ of ____

(Affix label or complete district information.)

COUNTY	DISTRICT	ESC

District Name

City

I. LEARNING AREA *(check one)*

☐ Language Arts
☐ Mathematics
☒ Sciences
☐ Fine Arts
☐ Social Sciences
☐ Physical Development/Health

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will have a working knowledge of the principles of scientific research and their application in simple research projects.

Contact Person: ____________
Title: ____________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Demonstrate the ability to draw conclusions from collected data.					

ISBE 41-78 (1/86)

Agricultural Business and Management
Agricultural Engineering/Mechanization

Illinois Agricultural Core Curriculum Rev.

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date ____________
☐ Original submission ☐ Revision
Page ____ of ____

I. LEARNING AREA *(check one)*
☐ Language Arts
☐ Mathematics
☒ Sciences
☐ Fine Arts
☐ Social Sciences
☐ Physical Development/Health

(Affix label or complete district information.)
COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐
District Name
City

Contact Person: ____________
Title: ____________
Phone: (   )

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will have a working knowledge of the process, techniques, methods, equipment, and available technology of science.

III. LEARNING OBJECTIVES	IV. ASSESSMENT A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	V. EXPECTATIONS Percent of Students Expected to Achieve Objective
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:					
*1. Construct a classification scheme and demonstrate its use.					
*2. Identify appropriate methods of measurement for a given task.					
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ISBE 41-78 (1/88)

Welding and Metalworking

Agricultural Business and Management
Agricultural Engineering/Mechanization

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agricultural Engineering/Mechanization

PROBLEM AREA: Welding and Metalworking

STUDENT LEARNING OBJECTIVES

Upon completion of their study of this problem area, students will be able to:

1. Understand how steel is manufactured.
2. Identify metals by:
    a. Color
    b. Weight
    c. Flame testing
    d. Magnetic properties
    e. Chemical tests
    f. Heat testing
    g. Spark testing
    h. Fracture testing
    i. Torch testing
    j. Hardness testing
    k. Color code
    l. Numbering system
    m. Standard steel shapes
3. Identify metals by their physical properties of:
    a. Melting point
    b. Coefficient of thermal expansion
    c. Coefficient of thermal conductivity
    d. Coefficient of electrical conductivity
    e. Density
    f. Color
    g. Luster
    h. Processes involved with "family steel"
4. Understand the following mechanical properties of metal:
    a. Stress
    b. Strain
    c. Hardness
    d. Tensile strength
    e. Compressive strength
    f. Ductility
    g. Wearability
    h. Machinability
    i. Yield strength
    j. Yield point
    k. Shear strength
    l. Torsional strength
    m. Malleability
    n. Creep strength
    o. Elastic limit
    p. Endurance limit
    q. Toughness
5. Identify some of the common uses of iron, carbon steel, and alloy steel.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agricultural Engineering/Mechanization

PROBLEM AREA: Welding and Metalworking

PROBLEMS AND QUESTIONS FOR STUDY

1. What are the ingredients used in melting steel?
2. What are the different processes used in making steel?
3. What are the basic shapes into which raw steel is formed?
4. What are some of the processes of forming steel into usable shapes?
5. How can metals be identified?
6. Into what two groups are metals classified?
7. What are the two common industrial classifications of steels?
8. What physical properties of metals are commonly measured?
9. What mechanical properties of metals are commonly measured?
10. What relationships exist between mechanical properties of metals?
11. Of what use is the identification of metal and its physical and mechanical properties when welding and metalworking?

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agricultural Engineering/Mechanization

PROBLEM AREA: Welding and Metalworking

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES

1. Obtain uniform samples of various types of metals along with specific information about each type of metal. Using this collection of metals, make a display that identifies the different types of metals and their characteristics and uses.

2. Arrange a field trip to a welding shop or a machine shop. Ask the owner or employee to demonstrate how they identify different types of metal and discuss the need for the proper identification of metals.

3. Arrange a field trip to a manufacturer, such as a heavy equipment manufacturer, who purchases and processes metal products. Ask permission to speak with employees in charge of testing and measuring the physical and mechanical properties of metals.

4. Construct a list of metal parts and tools composed of various types of metal. Have students research the type of metal used for the metal part or tool of their choice. Manufacturers may need to be contacted to determine specific information.

5. Plan a class trip to a steel mill to observe the steel manufacturing process. If a tour is not possible, a film of the process would be beneficial. Samples of iron ore, coke, and limestone could be obtained to enhance class discussion.

6. Many salvage yards are a good source of many different types of metals. Samples may be obtained for class and/or lab use.

7. Give each student a piece of unknown metal scrap. Make all pieces as uniform as possible. (You may even consider painting all pieces the same color.) The identification of each piece should be known by the instructor. Students will attempt to identify their metal sample using any test available. They should prepare a written report describing the properties of their metal sample and the procedures or tests used to determine each property, and identifying the particular metal of the sample.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agricultural Engineering/Mechanization

PROBLEM AREA: Welding and Metalworking

REFERENCES

*1. *Ferrous Metals —Properties, Identification, and Treatment* (VAS Unit #U3041). Vocational Agriculture Service, College of Agriculture, University of Illinois, 1401 S. Maryland Drive, Urbana, IL 61801. (217) 333-3871.

*2. *Welding, Fundamentals of Service.* (1974). 2nd edition. Deere & Company, Service Publications Department, 1400 13th Street, East Moline, IL 61284. (309) 765-2967.

*3. *Manufacturing Process.* (1984). Johnson, Harold V. 2nd edition. Glencoe Publishing Company, Front and Brown Streets, Riverside, NJ 08075. (609) 461-6500.

4. *Metals and Welding.* Morford, V.J., Hoerner, T.A., Anderson, W.R. Hobar Publications, 1234 Tiller Lane, St. Paul, MN 55112. (612) 633-3170.

5. *Welding.* (1985). Giachimo and Weeks. American Technical Publisher, 1155 W. 175th Street, Homewood, IL 60430. (800) 323-3471.

6. *Modern Welding.* (1984). Althouse, Turnquist, Bowditch. Goodheart-Willcox Company, 123 W. Taft Drive, South Holland, IL 60473. (800) 323-0440.

7. *The Procedures Handbook of Arc Welding.* Lincoln Electric Company, 22801 St. Clair Avenue, Cleveland, OH 44117. (216) 481-8100.

8. *Metal Craftsman's Handbook —An Illustrated Dictionary of Metalworking.* (1984). AAVIM, 120 Engineering Court, Athens, GA 30602. (800) 228-4689.

9. *The Oxy-Acetylene Handbook.* Linde Reference Library, Union Carbide Welding Products, Union Carbide Carbon Comany, Inc., Old Ridgebury Road, Danbury, CT 06817. (203) 794-2000.

10. *The Welding Encyclopedia Study Guide & Workbook.* Jefferson, Ted B. Jefferson Publications, Monticello Books Division, 44 S. Old Rand Road, Box 788, Lake Zurich, IL 60047. (312) 438-4114.

11. *Metallurgy.* Johnson and Weeks. Revised by Anderson. 5th edition. American Technical Publisher, 1155 W. 175th Street, Homewood, IL 60430. (800) 323-3471.

12. *Oxyacetylene Welding and Cutting* (VAS Unit #U3001A); *Cold Metal Work* (VAS Unit #U3002A); *Shielded Metal Arc Welding* (VAS Unit #U3004A); *Hot Metal Work* (VAS Unit #U3043); *Tungsten Inert Gas (TIG) Welding* (VAS Unit #U3043); *Metal Inert Gas (MIG) Welding* (VAS Unit #U3037). Vocational Agricultural Service, College of Agriculture, University of Illinois, 1401 S. Maryland Drive, Urbana, IL 61801. (217) 333-3871.

*Indicates highly recommended reference

INSTRUCTOR'S NOTES AND REFERENCES

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INSTRUCTIONAL RESOURCES

These resources are intended for use by teachers in planning and teaching the materials for this problem area and may be adapted to fit the teaching method(s) used.

INFORMATION SHEET #1 — Electric Arc Furnace

INFORMATION SHEET #2 — Making Cast Iron

INFORMATION SHEET #3 — Shaping Steel

INFORMATION SHEET #4 — Forming Seamless Tubing

INFORMATION SHEET #5 — Identification of Metals by Color and Weight

INFORMATION SHEET #6 — Identification of Metals by Chemical and Magnetic Tests

INFORMATION SHEET #7 — Identification of Metals by Spark Test

INFORMATION SHEET #8 — Identification of Metals by Fracture Test

INFORMATION SHEET #9 — Identification of Metals by Flame and Torch Test

INFORMATION SHEET #10 — Identification of Metals by Hardness Testing and Color Grade

INFORMATION SHEET #11 — Identification of Metals by Numbering Systems

INFORMATION SHEET #12 — Terms to Be Defined

TRANSPARENCY MASTER #1 — Blast Furnace (with discussion guide)

TRANSPARENCY MASTER #2 — Open Hearth Furnace (with discussion guide)

TRANSPARENCY MASTER #3 — Bessemer Converter (with discussion guide)

TRANSPARENCY MASTER #4 — The Steel Manufacturing Process (with discussion guide)

TRANSPARENCY MASTER #5 — Types of Metals

TRANSPARENCY MASTER #6 — Standard Steel Shapes

TRANSPARENCY MASTER #7 — Spark Testing Metals

TRANSPARENCY MASTER #8 — Temperature Data (with discussion guide)

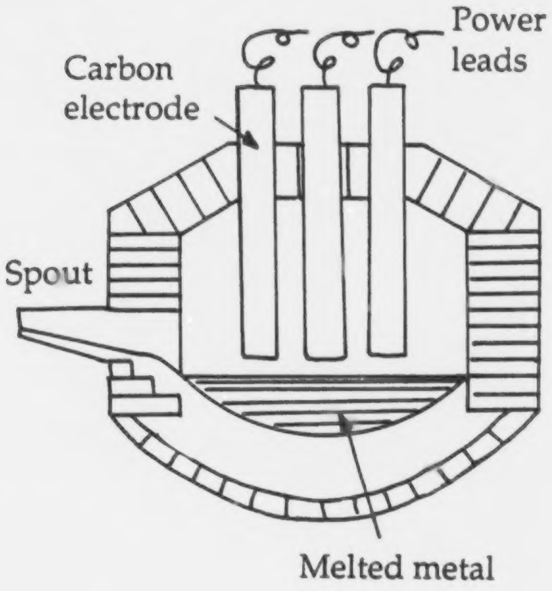
TRANSPARENCY MASTER #9 — Mechanical Stresses or Loads on Metals

TRANSPARENCY MASTER #10 — Physical Properties of Common Metals

INFORMATION SHEET #1

Electric Arc Furnace

High grade alloy steels, tool steels, and stainless steels are produced today in the electric furnace.



Carbon electrodes which create an arc to heat the metal to melting are lowered until they are just above the surface. No oxygen is necessary in an electric furnace. The oxygen would react with and burn out some of the alloying elements. The alloying compounds are added to remove impurities and to insure that the steel is within the desired specifications.

Induction Furnace

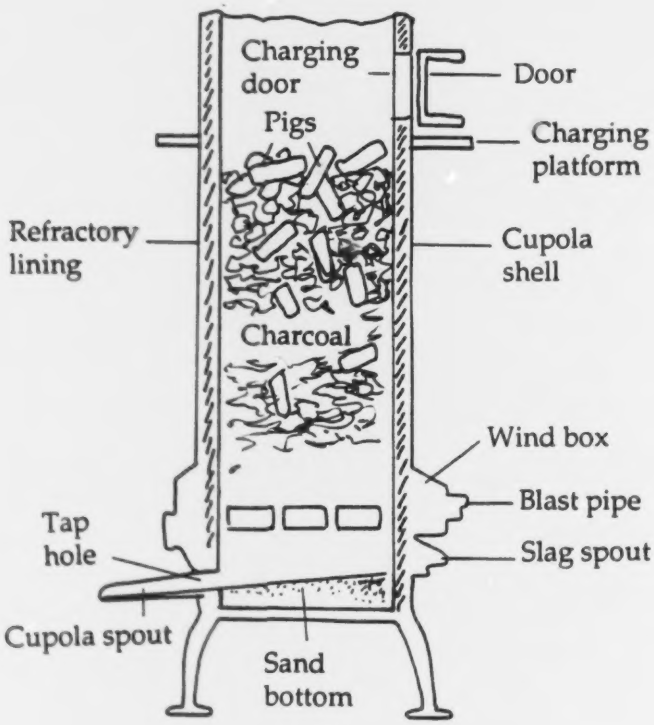
This furnace makes use of a high frequency alternating current which passes through a coil wound around but not in contact with it. The main advantage of the induction-heated electric furnace is the action of the magnetic flux lines which stir the melt. Also, there is very little slag formed.

INFORMATION SHEET #2

Making Cast Iron

A cupola furnace is charged with charcoal and billets of pig iron. Hot air is forced into the bottom which allows the charcoal to burn and melts the pig iron. The burning charcoal and gases also burn many impurities out of the pig iron. The molten iron drops to the bottom of the furnace where it is tapped off. The molten iron is then poured into molds where it takes the shape of the mold and hardens.

Although there are several types of cast iron, they all originate from the same furnace and have approximately the same chemical analysis. They differ mainly in the microstructure which is determined by the rate of cooling.


Charging door
Door
Pigs
Charging platform
Refractory lining
Cupola shell
Charcoal
Wind box
Blast pipe
Tap hole
Slag spout
Cupola spout
Sand bottom

Cast iron is made in a furnace called a cupola.

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INFORMATION SHEET #3

Shaping Steel

Steel may be found as castings, forgings, or rolled shapes. The largest tonnage of steel is in the rolled condition such as angles, bars, flats, etc. Most steel is rolled in a hot condition and at high speeds. Cold rolled steel is shaped when cold, under great pressures. Cold rolled steel may be formed more accurately to size and possesses high torsion strength and a smooth shining appearance.

Hot Rolled Mill Products

Ingots	Any shape, as cast
Blooms	Cross-sectional area 36 sq in min., usually square or rectangular
Billets	Cross-sectional area 36 sq in max., 1 1/2 in min. thickness, width at least twice thickness
Structural Shapes	Channels, I-beams, angles, etc.
Bars	Rounds, squares, hexagons, and flats
Rods	About 3/8-in diameter round and smaller, hot rolled
Plates	Thickness 3/16 in min. and of substantial width
Sheet	Thickness 3/16 in min. and of substantial width
Strip	Up to 1/4-in thickness and 12-in width

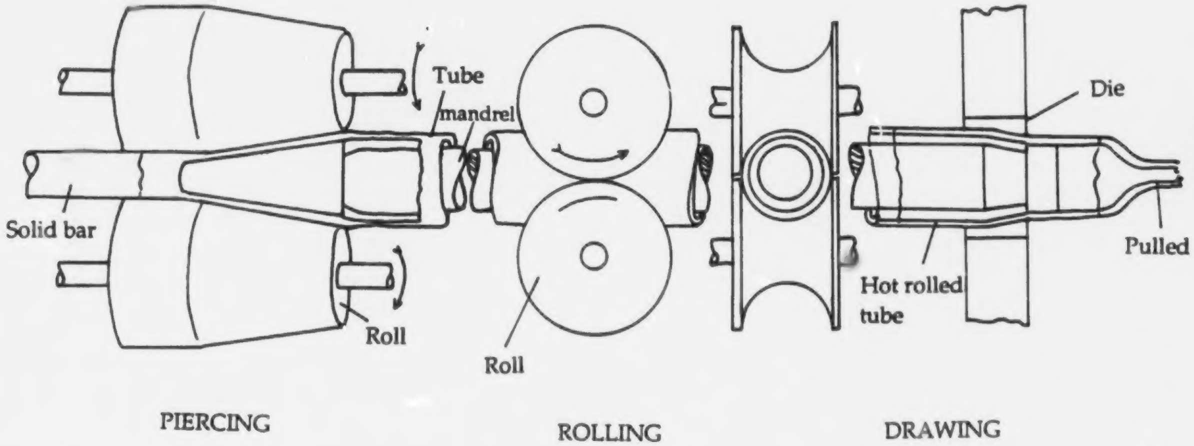
INFORMATION SHEET #4

Forming Seamless Tubing

Rolling — A process in which metal is passed between two rolls to press the metal to a designated thickness.

Piercing — A process by which tubing is manufactured. A bar of hot metal is rolled lengthwise between rolls so that the center opens up. As the center opens, the bar is fed over a mandrel and the mandrel opens the center to a specific diameter to form tubing.

Drawing — A process of forming a part by pulling it through a die so that the part takes the cross-sectional shape (size) of the die.



Seamless tubing is made by a combination of the processes of piercing, rolling, and drawing.

INFORMATION SHEET #5

Identification of Metals by Color and Weight

Color — Color is dependent upon the chemical composition of the metal. Copper, for example, has its own distinguishable color; so does brass. Color, however, cannot always be the sole criterion for identifying metal, because aluminum and magnesium, for example, have the same color and are obviously different metals.

Weight — It must be remembered that weight per unit volume or density is important. In the case of aluminum and magnesium the identification can be successfully accomplished by weight only if the pieces of metal to be identified are approximately the same physical size.

Properties of Principal Metals

Metal	Chemical symbol	Specific gravity	Weight per cu in (pounds)	Weight per cu ft (pounds)	Average melting point (degrees F)
Aluminum	Al	2.70	0.0975	168.5	1220
Antimony	Sb	6.618	0.2390	413.0	1167
Bismuth	Bi	9.781	0.3532	610.3	520
Boron	B	2.535	0.0916	158.2	4172
Brass*	—	8.6	0.3105	536.6	1560-1900
Bronze*	—	8.78	0.3171	547.9	1300-1800
Cadmium	Cd	8.648	0.3123	539.6	610
Chromium	Cr	6.93	0.2502	432.4	2939
Cobalt	Co	8.71	0.3145	543.5	2696
Copper	Cu	8.89	0.3210	554.7	1981
Gold	Au	19.3	0.6969	1204.3	1945
Iron	Fe	7.86	0.285	491.0	2802
Iron, cast*	—	7.03-7.73	0.254-0.279	438.7-482.4	1990-2300
Iron, wrought*	—	7.80-7.90	0.282-0.285	486.7-493.0	2750
Lead	Pb	11.342	0.4096	707.7	621
Magnesium	Mg	1.741	0.0628	108.6	1204
Manganese	Mn	7.3	0.2636	455.5	2300
Molybdenum	Mo	10.2	0.3683	636.5	4748
Nickel	Ni	8.8	0.3178	549.1	2651
Platinum	Pt	21.37	0.7717	1333.5	3224
Silver	Ag	10.42-10.53	0.376-0.380	650.2-657.1	1761
Steel, carbon*	—	—	0.283-0.284	489.0-490.8	2500
Tantalum	Ta	16.6	0.5998	1035.8	5162
Tellurium	Te	6.25	0.2257	390.0	846
Tin	Sn	7.29	0.2633	454.9	499
Titanium	Ti	4.5	0.1621	280.1	3272
Tungsten	W	1.86-19.1	0.672-0.690	1166-1192	6098
Uranium	U	18.7	0.6753	1166.9	3362
Vanadium	V	5.6	0.2022	394.4	3110
Zinc	Zn	7.04-7.16	0.254-0.259	439.3-446.8	788

*Properties may vary according to kind and amount of alloying elements or impurities.

INFORMATION SHEET #6

Identification of Metals by Chemical and Magnetic Tests

Metal	Chemical	Reaction	Magnetic	Nonmagnetic
Aluminum	Silver Nitrate 10%	None-White Spot		x
Magnesium	Silver Nitrate 10%	Black Spot		x
Inconel	Cupric Chloride	None-White Spot		x
Stainless Steel		Copper Spot	x	x
Aluminum	Caustic Soda			
Series 2xxx		Black		x
Series 6xxx		Black		x
Series 7xxx		Black		x
Series 1xxx		None-White		x
Series 3xxx		None-White		x
Series 4xxx		None-White		x
Series 5xxx		None-White		x
Aluminum	Cadmium Chloride			
Series 2xxx		None-White		x
Series 6xxx		Black		x
Series 7xxx		None-White		x
Monel	Nitric Acid	Green	x	
K-Monel		Green		x

INFORMATION SHEET #7

Identification of Metals by Spark Test

This is a common test that is used for the identification of ferrous metals (except titanium) but is rather unreliable. This test is best used for comparing an unknown specimen to a known specimen on a grinding wheel. This test will not identify stainless steel from carbon steels, or steels containing a high carbon content from steels containing a low carbon content. The spark test is very difficult to use to distinguish different alloys and in this respect is rather unreliable.

If the spark test is to be used to identify metals, it is important that equal pressure be applied to all pieces. A heavy continuous stream of sparks of bright intensity indicates that the wheel is cutting very fast. Sparks of less brightness at their source are an indication of a cooler cutting wheel.

The comparison chart explains the important differences among sparks from a wide variety of metals. The terms used are relative rather than absolute. The length of the spark stream depends on the pressure between the grinding wheel and the work. The apparent color depends upon the light in which the sparks are observed. The difference between red and orange, for example, is very slight. Each of these two colors might be called the other when one spark stream is observed without reference to the other. The colors called straw and white in the table might be called yellow depending upon the light in which the inspection is made. Neither sketches or photographs can convey a true picture of spark patterns as seen by the human eye. The sketches simply help to classify and illustrate the important differences.

Spark Test Characteristics of Metals

METAL	VOLUME OF STREAM	RELATIVE LENGTH OF STREAM, INCHES	COLOR OF STREAM CLOSE TO WHEEL	COLOR OF STREAKS NEAR END OF STREAM	QUANTITY OF SPURTS	NATURE OF SPURTS
Wrought iron	Large	65	Straw	White	Very few	Forked
Machine steel	Large	70	White	White	Few	Forked
Carbon tool steel	Moderately large	55	White	White	Very many	Fine, repeating
Gray cast iron	Small	25	Red	Straw	Many	Fine, repeating
White cast iron	Very small	20	Red	Straw	Few	Fine, repeating
Annealed mall. iron	Moderate	30	Red	Straw	Many	Fine, repeating
High-speed steel	Small	60	Red	Straw	Extremely few	Forked
Manganese steel	Moderately large	45	White	White	Many	Fine, repeating
Stainless steel	Moderate	50	Straw	White	Moderate	Forked
Tungsten-chromium die steel	Small	35	Red	Straw	Many	Fine, repeating
Nitrided nitralloy	Large (curved)	55	White	White	Moderate	Forked
Stellite	Very small	10	Orange	Orange	None	—
Cemented tungsten carbide	Extremely small	2	Light orange	Light orange	None	—
Nickel	Very small	10	Orange	Orange	None	—
Copper, brass, aluminum	None	—	—	—	None	—

Specific Spark Patterns

1. **Wrought iron** is almost pure iron. The spark stream of wrought iron, which normally contains not more than 0.08% carbon, consists of long, moderately bright carrier lines. Each of these thickens towards the end and is followed by a fairly dull arrowhead separated by a small gap from the rest of the spark. The spark stream consists of numerous individual sparks ranging in length up to several inches. The long spark stream is the effective length under ideal conditions for the tests.

2. **Machine steel** yields a few plain forked spurts. The carrier lines end in forks, while the arrowheads are barely detectable. The carriers are white and somewhat brighter than for wrought iron.

3. In **carbon tool steel** the explosions increase and assume more intricate patterns. As the carbon content is increased up to 0.6%, the stream gets brighter and the bursts more pronounced. When carbon content exceeds 0.6%, the stream appears somewhat duller in color and the intense bursts become smaller and more complicated in structure. For carbon steel the spark pattern is so profuse that the stream becomes very bushy. The particles from the initial explosion dart out and repeat with secondary spurts that produce a fine branching network of light.

4. With **cast iron** the streaks near the wheel are red and the spurts are similar to those from carbon tool steel. The length of the stream from the different types varies. White or hard cast iron shows many fine noncurving streaks close to the wheel. Sparks from the malleable iron are more profuse than from gray cast iron.

5. **High-speed steel** is easy to recognize by the spark test. The dull color near the wheel and the long spark stream are very apparent.

6. **Manganese steel** yields a stream with a very high temperature. The brilliance of the spark stream is due to the fine chip size and the easy oxidation. Manganese affects the spark stream in much the same way as carbon does. This makes it easily confused with plain carbon steel. A more positive identification of manganese steel is that it is nonmagnetic. So always supplement the spark test with the magnetic test.

7. **Stainless steel** may be confused with machine steel. However, stainless steel sparks are of a less brilliant color near the wheel and the stream itself is thinner. Chromium indicates its presence in steel by shortening of the spark stream without affecting the brightness. The spark stream of stainless steel differs from the stream produced by plain carbon steel by the lesser density of the spark stream and the greater variety of stream types produced, depending upon the composition of the metal.

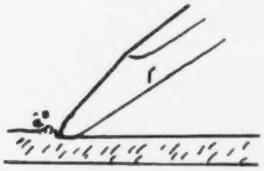
8. **Tungsten-chromium die steel** is noticeably different from cast iron because the spark pattern has a blue-white glow at the spurts.

9. **Nitrided nitralloy** exhibits a peculiar characteristic. The sparks near the wheel form whorls and some actually turn from the main line of travel as much as 90 degrees. The same tendency, though to a much lesser extent, is exhibited by manganese steel.

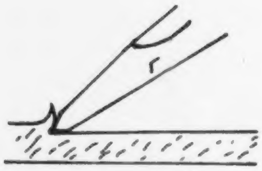
INFORMATION SHEET #8

Identification of Metals by Fracture Test

Fracture test — Many metals can be identified by the appearance of the surface of the broken part or by studying the chip produced by a chisel.



Cast Iron
Breaks off in
small particles



Mild Steel
Curls and clings

1. **Wrought iron** can be bent and is quite ductile. When nicked and bent to the breaking point, the break is jagged. This iron has a fibrous structure and can be split in the direction in which the fibers run. It is easily cut with a chisel.

2. **Gray cast iron** gets it name from the fine specks of graphite dispersed through the metal. If you nick a corner of gray cast iron with a chisel, the break will be short and the exposed surface dark gray in color. The chips caused by the chisel will break off as soon as they are formed.

3. **Malleable iron** is much stronger than cast iron and does not break short when nicked with a chisel. The central portion of a broken surface of malleable iron is dark gray with a bright steel-like band around the edge similar to a picture frame.

4. **Low-carbon steels** are tough when chipped or nicked and have a bright crystalline color.

5. **High-carbon steels** are harder and more brittle than low-carbon steels and the fracture is whiter and finer grained.

6. **Steel forgings** may be of low-carbon, high-carbon, or tool steel and the color will vary from a bright crystalline to silky gray. When a specimen is nicked, it is harder to break than cast iron steel and it has a finer grain.

Cast steel is tough and does not break short. If you break up chips with a chisel, they tend to curl up. Manganese steel cannot be cut with a chisel. The surface of fractured areas of cast steel are bright crystalline.

INFORMATION SHEET #9

Identification of Metals by Flame and Torch Test

Flame Test:

There are several metals that will burn readily. Examples of these are sodium, phosphorus, magnesium, and titanium. The most common use of the flame test is to distinguish aluminum from magnesium. Make some fine filings and heat with a flame, such as a propane torch. The magnesium filings will burn with a brilliant white glow while the aluminum filings will not burn but will simply melt away.

Torch Test:

Many metals can be identified by observing the reaction of an oxyacetylene flame as it is applied to the metal.

1. **Wrought iron** melts quickly, with a slight tendency to spark. The melted iron has a greasy or oily appearance and a slag that is marked with white lines.
2. **Gray cast iron** has a heavy, tough film that forms on the surface as it melts. The puddle is very fluid and, as the torch flame is removed, the depression in the surface of the puddle disappears instantly. The molten puddle solidifies slowly and does not give off sparks.
3. **Molten malleable iron** boils under the torch flame, and when the flame is withdrawn the surface is full of blowholes. The melted part cools very hard and brittle. It is, in fact, white or chilled cast iron that is produced by the melting and comparatively rapid cooling. The outer, steel-like shell will give off sparks under the torch. The center portion of the puddle will not.
4. **Steel forgings** spark when melted. The greater the carbon content, the greater the number of and brilliance of the sparks.
5. **Low-carbon steels** give off sparks when melted and solidify almost instantly when the flame is removed.
6. **High-carbon steels** appear brighter when molten than the low-carbon steels and the melted surface has a cellular appearance.
7. **Cast steel** gives off steel sparks when melted and solidifies very quickly

INFORMATION SHEET #10

Identification of Metals by Hardness Testing and Color Grade

Hardness Testing:

Testing a metal for hardness may be done to determine the ability of a material to resist penetration, deformation, or wearing away due to an abrasive action. Hardness testing is also used to help determine an approximate tensile strength value. Nonferrous alloys, however, cannot be converted into tensile strength values.

The hardness of a metal depends on various factors, physical properties, heat treatment, method of fabrication, and others. Hardness is directly related to other properties, such as tensile strength and toughness. The international standard of measurement of hardness is called the "Rockwell" test. It is based on the amount of depth penetration that results from increasing the minor load pressure to the major load pressure in a testing machine. The minor load pressure (10 kg) is applied to seat the penetrator, followed by the major load pressure (60-150 kg). The hardness reading is a measurement of the increment between the two loads. The principle is the same whether a diamond penetrator or a steel ball is used.

Other types of machines, such as the "Brinnel" and "Vickers," operate on the principle of applying a known weight to a known size of penetrator. A 10-millimeter. steel ball is used for the Brinnel test and a pyramid diamond for the Vickers. The area of penetration is then measured to determine the hardness.

Color Grade:

Color codes are used by some mills as a means of identifying both steel and aluminum. The representative of the mill can identify a metal by color code, if you cannot find it.

Common Steel Color Designations:

Color designation is not completely standardized by the steel industry or by manufacturers. The color is usually sprayed on the ends of the steel bars. The following are the color designations used by a steel supplier.

1. Green — C 1015 to C 1025
2. Blue — C 1035
3. Yellow — C 1040 to C 1045
4. Pink — C 1095
5. Brown — C 1140
6. Gold — C 1117
7. White — B 1112
8. Orange — B 1113

INFORMATION SHEET #11

Identification of Metals by Numbering System

For many years the Society of Automotive Engineers (SAE) classified steel by a four-digit number. This system designates the first digit as the principal alloying element present. The second digit represents the amount of alloying element present. The last two digits indicate the points of carbon in the steel, where one point is 0.01%. This system has been known as the SAE numbering system.

Eventually the number of alloy steels increased to such an extent that the system could not give clear identification of a type. A new identification was developed through the joint efforts of the Society of Automotive Engineers and the American Iron and Steel Institute (AISI). The numbers used in both systems are now essentially the same; however, the AISI code uses a letter before the number to indicate the method by which a particular steel is produced:

1. B — Acid Bessemer carbon steel.
2. C — Basic open-hearth or basic electric furnace carbon steel.
3. E — Electric furnace alloy steel.
4. CB — Either Bessemer or open-hearth process at the option of the mill.

In the SAE and AISI systems, the first number frequently, but not always, indicates the basic type of steel as follows:

1. Carbon
2. Nickel
3. Nickel-chromium
4. Molybdenum
5. Chromium
6. Chromium-vanadium
7. Tungsten
8. Nickel-chromium-molybdenum
9. Silicon-manganese

The first two digits represent the alloy or alloys present. The last two digits of the four-numeral series are intended to indicate the approximate middle of the carbon range. In some cases five digits are given and the last three represent the carbon content as in the high carbon-chromium bearing steels.

As an example, consider the AISI-SAE identification number E51100. The first character, E, indicates the steel was made in the electric furnace. The digit 5 indicates the steel is of chromium type. The next digit, 1, indicates that about 1 percent of the alloying element is chromium. The last three digits, 100 (meaning 1.00), indicate that the steel has a 1 percent carbon content.

TABLE 1. AISI and SAE Numerical Designations of Alloy Steels. (Elements are expressed in terms of percents)

Series	Types		
10XX	Nonsulphurized carbon steels		
11XX	Resulphurized carbon steels (free machining)		
12XX	Rephosphorized and resulphurized carbon steels (free machining)		
13XX	*Mn 1.75		
23XX^	Ni 3.50		
25XX^	Ni 5.00		
31XX	Ni 1.25	Cr 0.65	
33XX	Ni 3.50	Cr 1.55	
40XX	Mo 0.20 or 0.25		
41XX	Cr 0.50 or 0.95	Mo 0.12 or 0.20	
43XX	Ni 1.80	Cr 0.50 or 0.80	Mo 0.25
44XX	Mo 0.40		
45XX	Mo 0.52		
46XX	Ni 1.80	Mo 0.25	
47XX	Ni 1.05	Cr 0.45	Mo 0.20 or 0.35
48XX	Ni 3.50	Mo 0.25	
50XX	Cr 0.25, 0.40 or 0.50		
50XXX	C 1.00	Cr 0.50	
51XX	Cr 0.80, 0.90, 0.95, or 1.00		
51XXX	C 1.00	Cr 1.05	
52XXX	C 1.00	Cr 1.45	
61XX	Cr 0.60, 0.80 or 0.95 V 0.12, 0.10 min., or 0.15		
81XX	Ni 0.30	Cr 0.40	Mo 0.12
86XX	Ni 0.55	Cr 0.50	Mo 0.20
87XX	Ni 0.55	Cr 0.05	Mo 0.25
88XX	Ni 0.55	Cr 0.50	Mo 0.35
92XX	Mn 0.85	Si 2.00	Cr 0 or 0.35
93XX	Ni 3.25	Cr 1.20	Mo 0.12
94XX	Ni 0.45	Cr 0.40	Mo 0.12
98XX	Ni 1.00	Cr 0.80	Mo 0.25

Consult current AISI and SAE publications for latest revisions.

^ Nonstandard steel

* Abbreviations

C - Carbon
Cr - Chromium
Mn - Manganese
Mo - Molybdenum
Ni - Nickel
Si - Silicon
V - Vanadium

TABLE 2. Classification of Carbon and Alloy Steels.

Type of steel	ANSI No. (1942)	SAE No. (1942)	Characteristics	Common Uses
Carbon	C1010	1010	Low tensile strength	Welding steel, nails
	C1020	1020	Very tough	Pipe, structural steel, sheet steel
	C1030	1030	Heat treats well	Shafting, gears
	C1040	1040	Average heat treating	Crankshafts, bolts, connecting rods
	C1045	1045	Careful quenching required of thin sections	Screwdrivers, auger bits
	C1060	1060	Soft tool steel	Lock washers, valve springs, upholstery springs
	C1070	1070	Very tough and hard	Wrenches, dies, knives, anvils
	C1080	1080	Holds keen edges	Chisels, hammers, shear blades
	C1085	1085	Tool steel — hard	Taps, dies, music wire, auto bumpers, knives
	C1090	1090	Tool steel — very hard	Milling cutters, springs, taps, hacksaw blades
	B1112	1112	Good machining	Screw machine parts, bolts, screws
	C1115	1115	Strong and tough	Screw machine stock
	C1117	X1314	Case hardens well	Surface hardening products
	C1132	X1330	Good machinability	Used where hardness is desired
Manganese	A1330	1330	Hard wear and shock characteristics	Safes, curved rails
Nickel	A2317		Shock resisting	Steel rails, armor plate, wire cable
Nickel-chromium	A3115	3115	Very hard and strong	Gears, springs, axles, armor plate
Molybdenum	A4130	4130	Withstands high heat and hard blows	Ball and roller bearings, high grade machine and auto parts
Chromium	A5120	5120	Hard and tough	Safes, cutting tools, bearing rollers
Chromium-vanadium	E6150		Resists corrosion	Axles, frames, tools, chisels
Stainless-chromium	414	51310	Can be heat treated	Sinks, cooking utensils

INFORMATION SHEET #12

Terms to Be Defined

Coefficient of thermal conductivity — a number which tells how fast a material will transfer heat from one part to another. Materials that have a high coefficient of thermal conductivity transfer heat quickly from one part to another. Copper has a high coefficient of thermal conductivity and requires a lot of heat for welding. Stainless steel has a low coefficient of thermal conductivity and requires comparatively little heat for welding.

Coefficient of thermal expansion — a number which represents the amount of expansion of a material when heated. Materials that have a high number warp considerably during welding.

Color — property of a material that causes it to reflect light at a certain wavelength. Different wavelengths produce different sensations on our visual senses. This is what gives us our impressions of colors. Color is a big aid to the metalworker in identifying metals and alloys. Copper and its alloys are recognized by their reddish or bronze color and aluminum alloys have a light gray color.

Compressive strength — the maximum strength that can be developed in that material under a compressive load.

Creep strength — the maximum stress in a material that will result in creep. Creep is a plastic flow of material held for a long period of time at stresses lower than the normal yield strength.

Density — weight per unit volume of a material. Density may be expressed as pounds per cubic foot or pounds per cubic inch. Cast iron has a density of approximately 1/4 pound per cubic inch while 2024 aluminum alloy has a density of approximately 1/10 pound per cubic inch. Ferrous metals are usually heavy while nonferrous are usually light.

Ductility — property of a metal which permits a permanent deformation before it fractures in tension or under torsion. Ductility is usually expressed as percent elongation or percent reduction in area.

Elastic limit — the maximum stress that a material will withstand without permanent deformation.

Endurance limit — the maximum stress that a material will withstand without failure during a specified long number of cycles of stress. A spring which can be flexed millions of times under a heavy load without breaking has a high endurance limit.

Hardness — generally a measure of resistance to indentation. For special applications, hardness may be measured in terms of resistance to scratching, wear, or impact.

Luster — ability of a material to shine or glisten by reflecting light. Some materials, such as copper and stainless steel, can be polished to a very bright luster. Other metals, such as gray cast iron, cannot be made to take a luster. Luster, like color, can be used in the aid and identification of metals and alloys.

Machinability — measure of the speed at which a material may be machined, the life of a cutting tool, or the quality of finish.

Malleability — ability of a material to be hammered or rolled into thin sheets.

Mechanical properties — those properties of a metal or an alloy which involve the relationship between stress and strain.

Melting point — the temperature at which a metal changes from a solid to a liquid. Different metals have different melting points. Pure aluminum melts at 1220°F, and pure iron melts at 2800°F.

Physical properties — those properties of a metal or an alloy which are determined by its chemical composition and which do not change by heat treatment.

Shear strength — the maximum stress which can be developed in a material under a shearing load.

Strain — change in dimension per unit of dimension. Linear strain is expressed in inches per inch. A 2-inch length is usually taken as a standard length for strain. If a piece of metal, when loaded, stretches 1 inch over the standard 2-inch length, the strain would be 1/2 inch per inch.

Stress — reaction within a material to an externally applied load. Stress is found by dividing the load by the original cross-sectional area. Stress is expressed in pounds per square inch (psi).

Tensile strength — the maximum stress that can be developed in the material under a tensile load. It is expressed in pounds per square inch.

Torsional strength — the maximum stress which can be developed in a material under a torsional load.

Toughness — property of a material which permits it to absorb considerable energy before fracture.

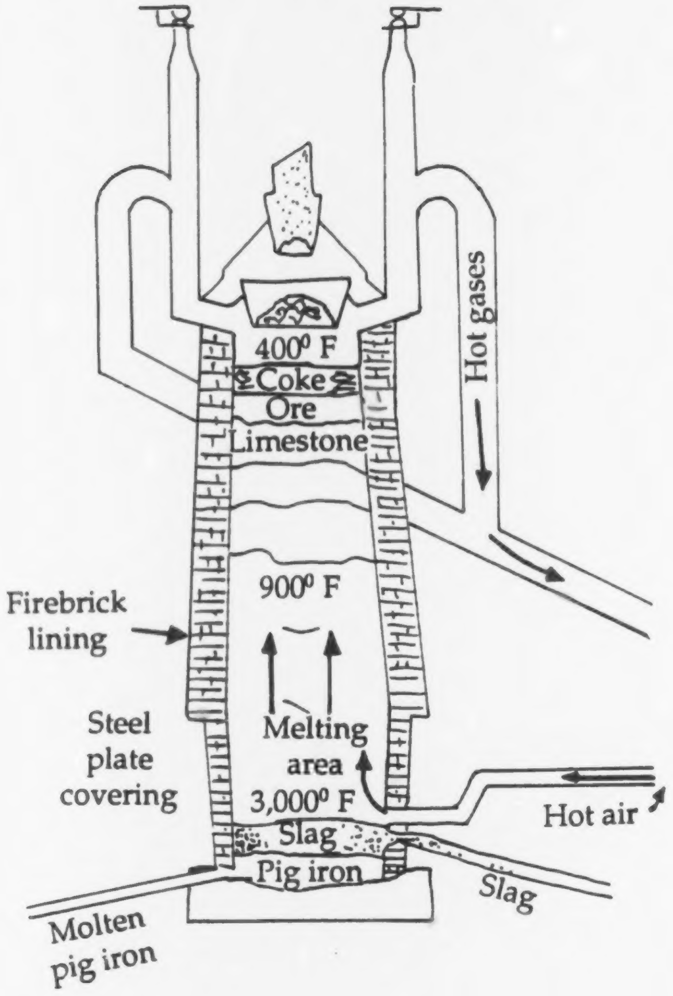
Wearability — measure of wear resistance. Wear is caused by abrasion of nonmetallic particles and/or by attrition of one metallic part moving upon another.

Yield point — the stress at which a marked deformation occurs without any increase in load. Mild- and medium-carbon steels are the only materials showing yield points.

Yield strength — the stress at which a material exhibits a specific permanent set.

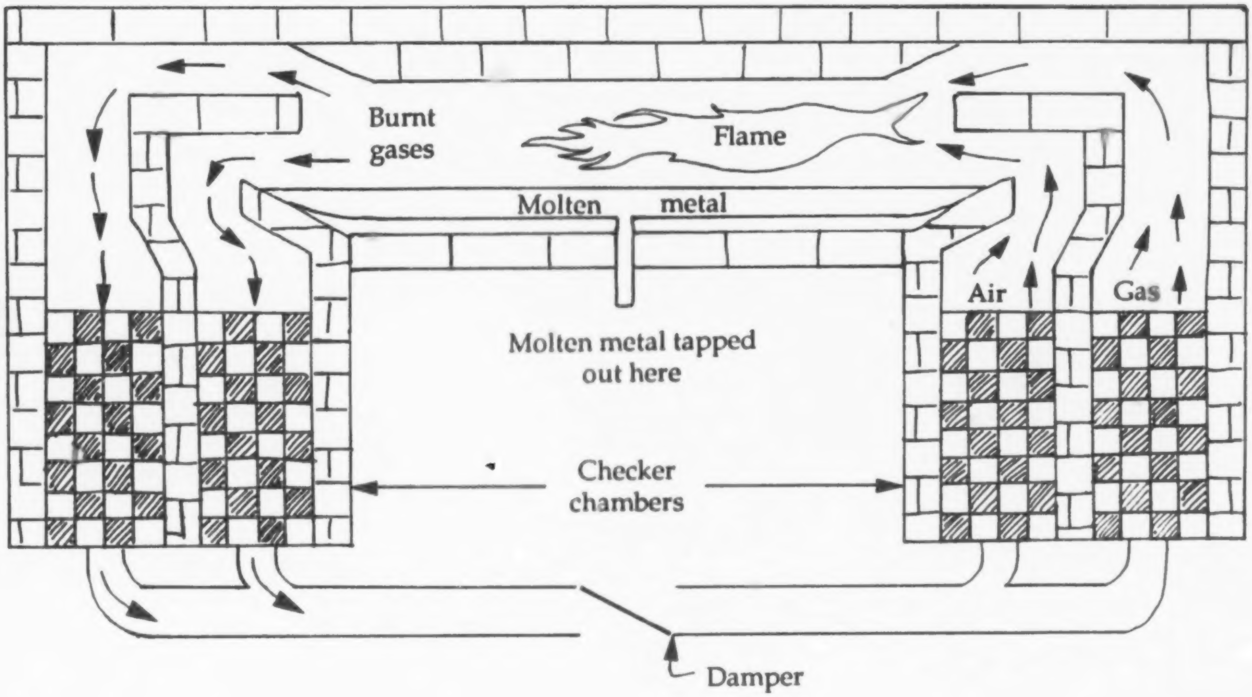
TRANSPARENCY MASTER #1

Blast Furnace


Hot gases
400° F
Coke
Ore
Limestone
900° F
Firebrick lining
Steel plate covering
Melting area
3,000° F
Hot air
Slag
Pig iron
Slag
Molten pig iron

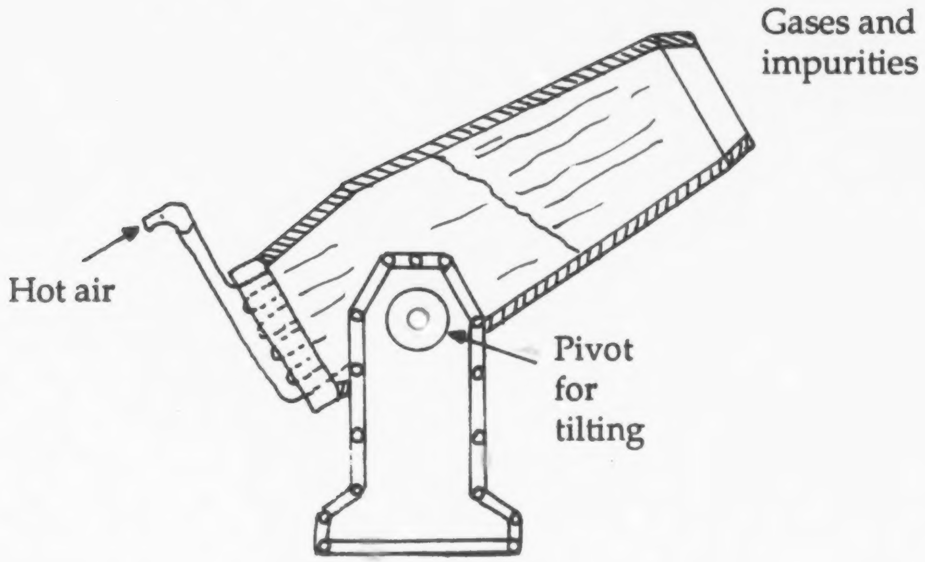
TRANSPARENCY MASTER #2

Open-Hearth Furnace


Burnt gases
Flame
Molten metal
Air
Gas
Molten metal tapped out here
Checker chambers
Damper

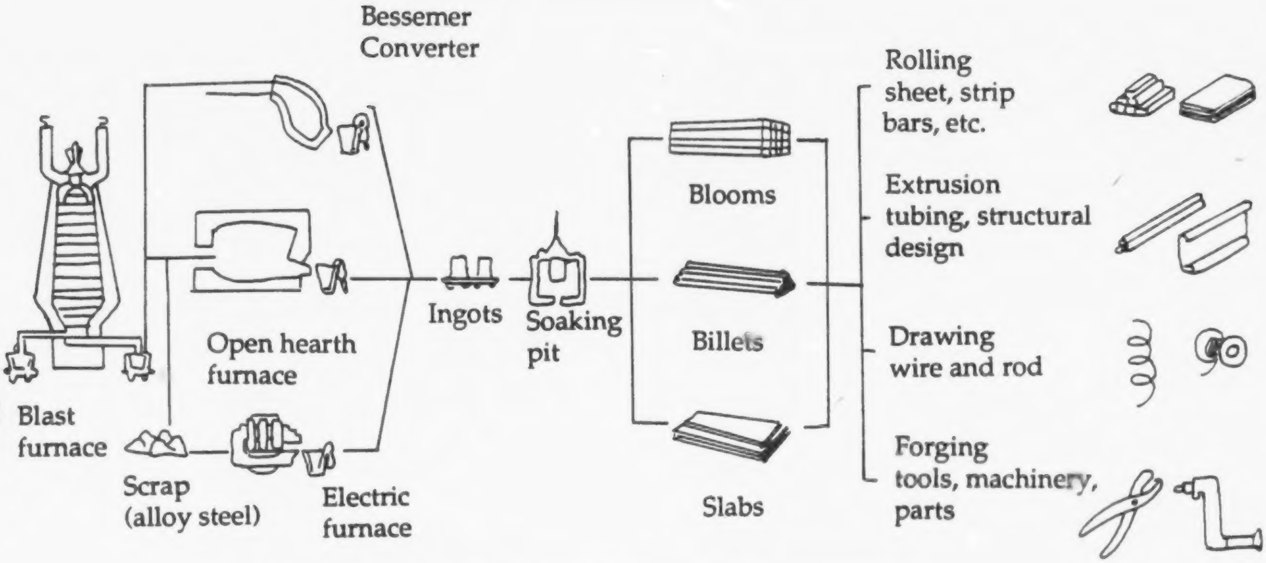
TRANSPARENCY MASTER #3

Bessemer Converter


Gases and impurities
Hot air
Pivot for tilting

TRANSPARENCY MASTER #4

The Steel Manufacturing Process


Bessemer
Converter
Blast
furnace
Open hearth
furnace
Scrap
(alloy steel)
Electric
furnace
Ingots
Soaking
pit
Blooms
Billets
Slabs
Rolling
sheet, strip
bars, etc.
Extrusion
tubing, structural
design
Drawing
wire and rod
Forging
tools, machinery,
parts

The flow of steel during the manufacturing process.

TRANSPARENCY MASTER #5

Types of Metals

Ferrous

Those metals having iron as the base element such as:

1. Cast iron
2. Wrought iron
3. Steels

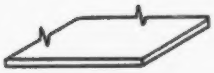
Nonferrous

Those metals having a base element other than iron such as:

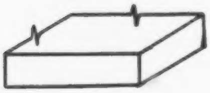
1. Copper
2. Brass
3. Zinc
4. Bronze
5. Lead
6. Aluminum
7. Others

TRANSPARENCY MASTER #6

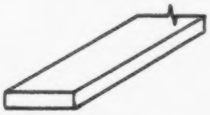
Standard Steel Shapes



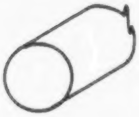
Sheets
3/16" thickness & less
(gauge)



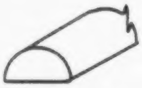
Plates
over 3/16" thickness



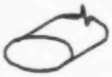
Flat bars
1/8" - 3" thickness
1/2" - 12" width



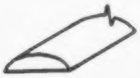
Rounds
3/16" to 10"



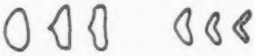
Half-rounds
3/8" to 3"



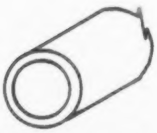
Ovals
1/2" x 1/4"
to 1-1/4" x 5/8"



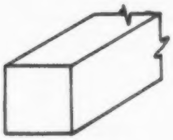
Half-ovals
3/8" x 3/32"
to 3" x 3/4"



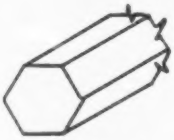
Angle



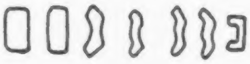
Tubes wall 1/4" to.31"
O.D. 2-9/16" to 12"
I.D. 2-1/16" to 11.3"



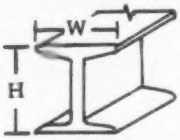
Squares
1/4" to 6"



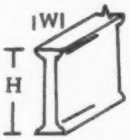
Hexagons
3/8" to 3"



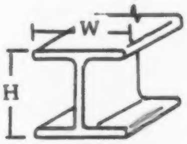
Channel



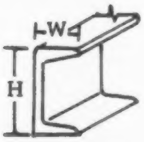
I-Beams
H. 3" to24"
W. 2.3" to 7.9"



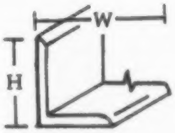
Joists
H. 6" to 12"
W. 1.8" to 3'



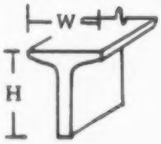
H-Sections
H. 4" to 36.7"
W. 4" to 16.6"



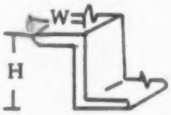
Channels
H. 1/2" to 18"
W. 1/4" to 4"



Angles
H. 1/2" to 8"
W. 1/2" to 8"



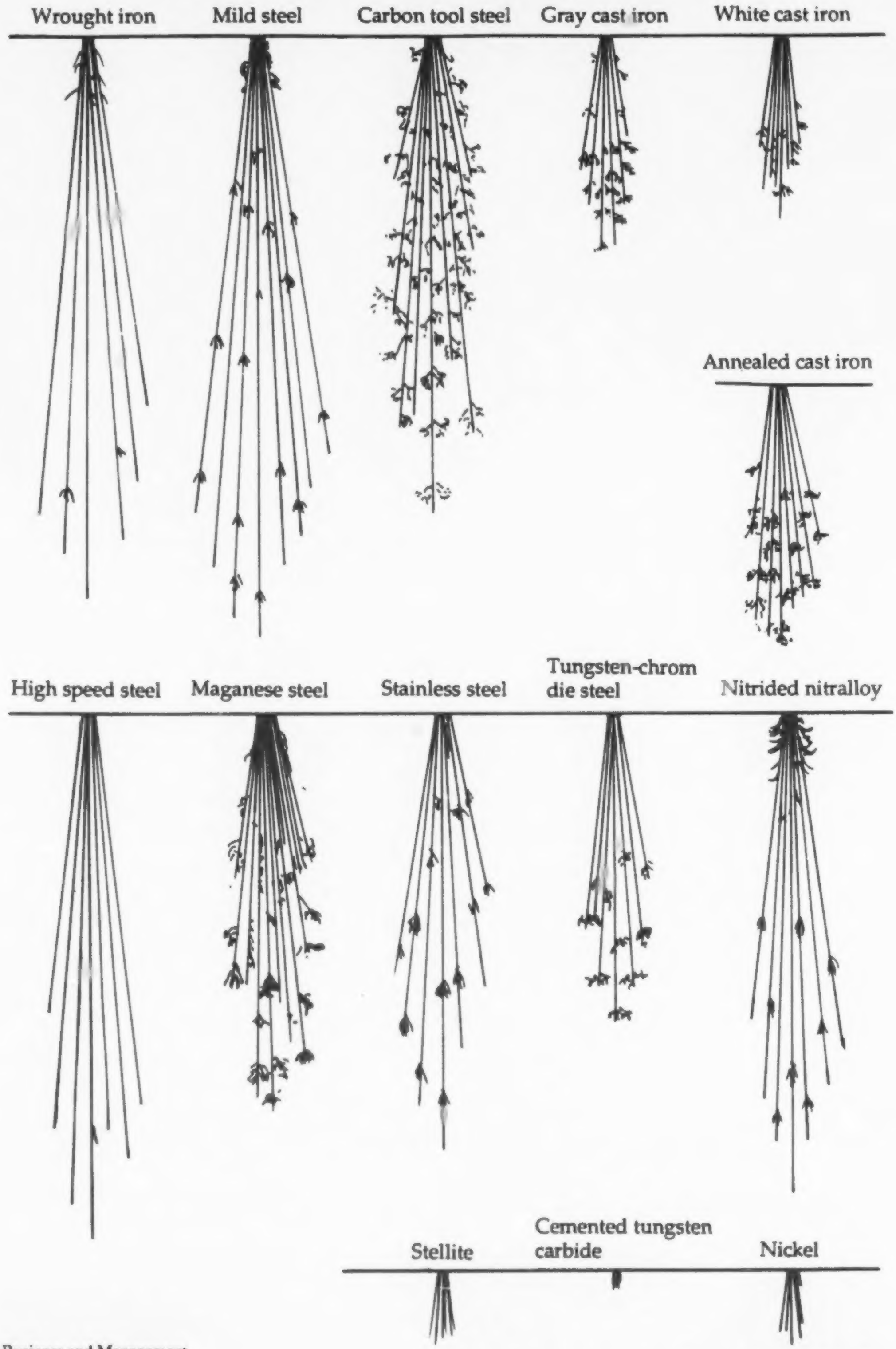
Tees
H. 3/4" to 6.5"
W. 3/4" to 6.5"



Zees
H. 1-3/4" to 6-1/8"
W. 1-1/4" to 3-5/8"

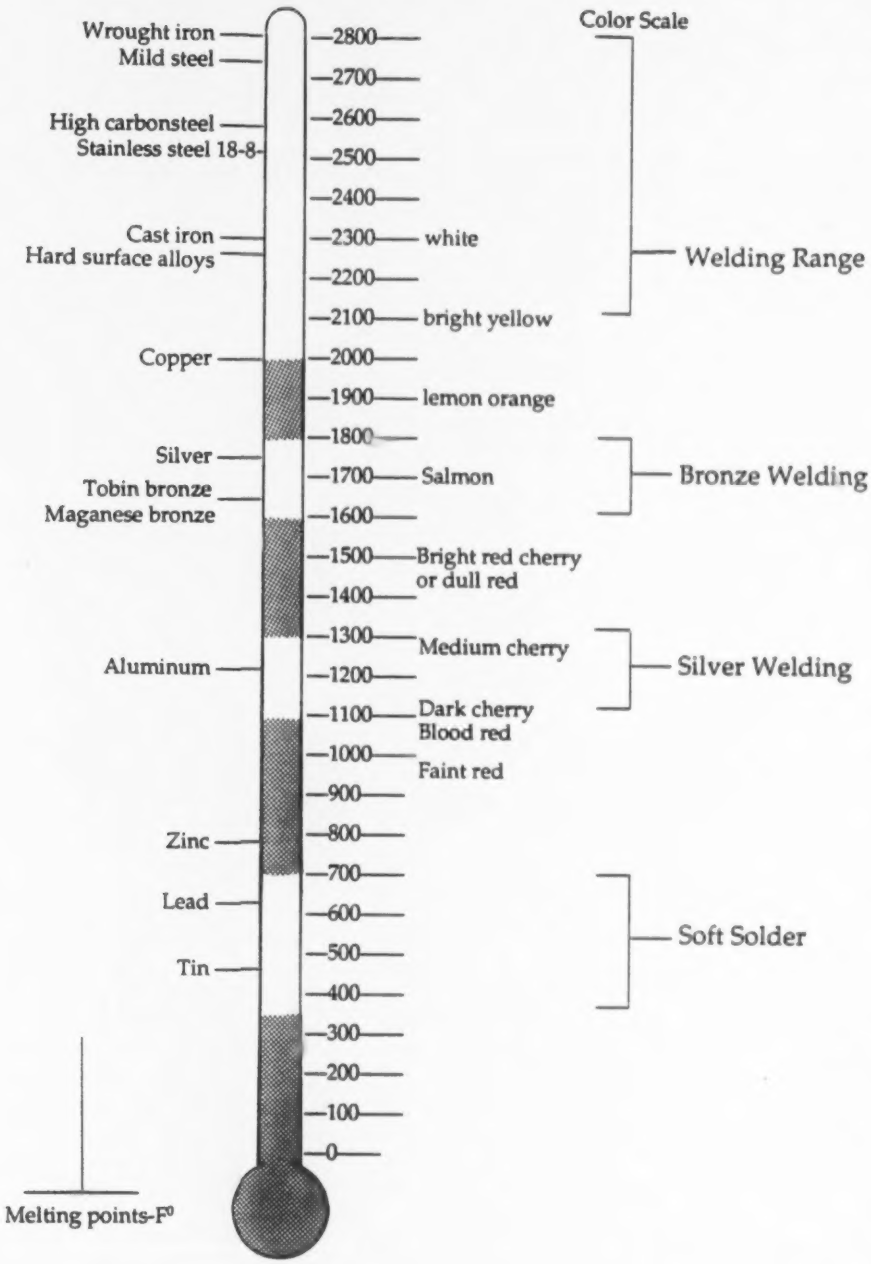
TRANSPARENCY MASTER #7

Spark Testing Metals


Wrought iron
Mild steel
Carbon tool steel
Gray cast iron
White cast iron
Annealed cast iron
High speed steel
Maganese steel
Stainless steel
Tungsten-chrom die steel
Nitrided nitralloy
Stellite
Cemented tungsten carbide
Nickel

TRANSPARENCY MASTER #8

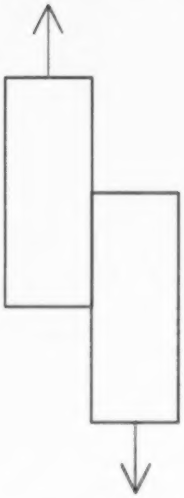
Temperature Data


Wrought iron
Mild steel
High carbonsteel
Stainless steel 18-8-
Cast iron
Hard surface alloys
Copper
Silver
Tobin bronze
Maganese bronze
Aluminum
Zinc
Lead
Tin
Melting points-F⁰
2800
2700
2600
2500
2400
2300
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
white
bright yellow
lemon orange
Salmon
Bright red cherry or dull red
Medium cherry
Dark cherry
Blood red
Faint red
Color Scale
Welding Range
Bronze Welding
Silver Welding
Soft Solder

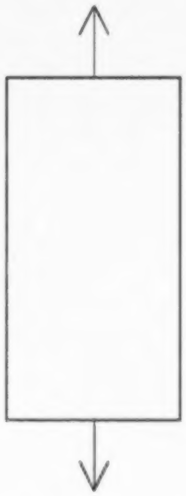
Note: To convert fahrenheit to centigrade:
Degree Centigrade = 519 x (Deg Fahrenheit - 32)

TRANSPARENCY MASTER #9

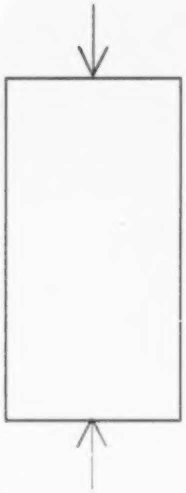
Mechanical Stresses or Loads on Metals



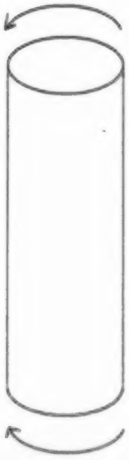
Shear



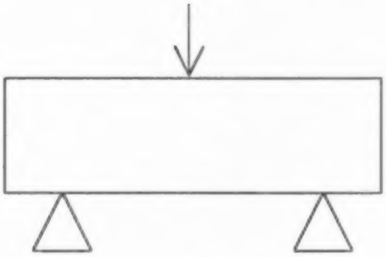
Tension



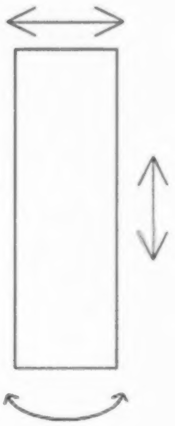
Compression



Torsion



Bending



Fatigue
(Combination
of Loads)

TRANSPARENCY MASTER #10

Physical Properties of Common Metals

Metal or Alloy	Melting Point (°F)	Coefficient of Thermal Conductivity (BTU per sq ft per in, per °F per min)	Electrical Conductivity (Silver considered 100%)	Coefficient of Thermal Expansion (Millionths of an inch per inch per °F)	Density (lbs/foot^3)	Color	Luster (After polishing)
Aluminum, Pure	1218	25.8	63%	12.43	168.5	Grayish	Medium
Aluminum, Alloy 2024	1180	20.6	53%	12.70	187.0	Grayish	Medium
Copper	1981	40.6	98%	9.00	554.7	Reddish	Bright
Gold	1945	34.2	77%	7.76	1204.3	Yellow	Bright
Lead	620	4.0	8%	16.30	707.7	White	Medium
Magnesium	1202	18.2	30%	14.45	108.6	White	Medium
Nickel	2645	10.8	13%	7.00	636	White	Bright
Silver	1762	48.6	100%	10.25	655	White	Bright
Steel, High Carbon	2500	5.2	12%	6.32	490	Grayish	Medium
Steel, Stainless	2550	1.74	13%	6.00	494.0	Grayish	Bright
Titanium	3270	1.68	14%	5.00	280.1	Grayish	Bright
Zinc	786	13.2	30%	21.00	442.0	White	Dull

TRANSPARENCY MASTER DISCUSSION GUIDE

Transparency Master #1

The first step in changing iron ore into steel takes place in a blast furnace. The blast furnace is filled with layers of ore, coke, and limestone. As the molten iron and slag are tapped off the bottom, more coke, ore, and limestone are added to the top.

The molten iron, or "pig iron," is taken to other furnaces for further refining or may be cut into bars. The amount of carbon and impurities in pig iron must be reduced to make it into steel.

Transparency Master #2

During the period from 1940 to 1960, the open-hearth furnace produced approximately 90% of the steel made in the United States. This process resembles the action of a huge welding flame.

The pig iron was generally taken directly from the blast furnace in the molten state, and poured into the open-hearth furnace along with scrap and limestone. The limestone melts and floats on top of the steel, collecting impurities and protecting the steel from the flame. Other materials may be added to react with certain impurities and cause them to burn out or form slags. Alloying elements may also be added at this time. When the composition is just right the molten steel is poured into a ladle.

Transparency Master #3

The Bessemer converter was developed in the late 1800s. This furnace has been superseded by two generations of refining furnaces, the open-hearth and the basic oxygen process. The Bessemer converter was used to produce machinery steel and structural steel.

Pig iron is put in the furnace and hot air is forced up through it. The air burns most of the carbon and other impurities out of the molten metal. As soon as the impurities are burned off the steel is poured into an ingot mold to harden.

A steelmaking process that later replaced the Bessemer process is the basic oxygen process. Instead of air being forced through the bottom of the converter, this process uses a water-cooled pipe, called a lance, that is lowered into the furnace. The lance is lowered to a level just above the pig iron. Oxygen at a rate of 20,000 cfm is blown into the furnace through the lance.

Transparency Master #4

The steel from the Bessemer, open-hearth, and electric furnace is poured into ingot molds to harden. As soon as the ingot hardens, the mold is removed. The ingot is then put into a soaking pit. This soaking pit is an underground furnace that soaks the ingots with heat.

The flow of steel during the manufacturing process is shown in this illustration. The ingot is then started through the rolling process. Rolling reduces the thickness and forms steel into plates, sheets, rods, bars, and other structural shapes.

Transparency Master #8

The right side of this chart indicates the welding/soldering range for iron and steel at various temperatures and the corresponding color changes that occur.

The red color begins to increase in intensity from about 950° to approximately 1600°. In this range the colors tend to get brighter as the temperature is increased. The left side of the chart indicates the melting point for different kinds of metals.

Steel should be preheated to prevent cracks from occurring due to uneven stresses formed by welding. The range at which preheating should take place depends upon the carbon content, but preheating should be done at temperatures from 100° up to about 800°. This is still called a black heat range.

From 300° to 700° is considered a blue brittle range. Steel should not be peened or worked between these temperatures since they are more brittle in this temperature range than they are above this temperature range or below it.

The temperature range from about 1700° for low carbon steel down to about 1400° for steel with a 0.9% carbon is called a transformation range. In this transformation range, steels undergo internal atomic changes that affect the properties of the steel.

Stress relieving is a process that consists of heating the steel until the lower transformation temperature is reached, holding that temperature long enough to relieve stresses that are locked up in the metal, and then cooling the steel very slowly. For stress relieving the temperature should not be increased above 1350°.

It is important to remember the melting temperatures of various metals as indicated in the left-hand scale. Notice that aluminum melts slightly above 1200°; you must also remember that aluminum oxide melts at a higher temperature than this, so the oxide must be removed before good welding of aluminum can take place.

STUDENT ACTIVITIES

STUDENT WORKSHEET #1 — Metals Questions

For additional activities, teachers may refer to the "Suggested Teaching Activities and Procedures" section in the Instructor's Guide.

STUDENT WORKSHEET #1

Metals Questions

Fill in the blanks or circle one answer in each set of parentheses or both.

1. The material used in the blast furnace that combines the ash and iron impurities to form slag is ___________.
2. The first step in changing iron ore to steel takes place in a _________ ___________.
3. The furnace for converting iron ore into pig iron is the _________ ___________.
4. The blast furnace is charged with ________, ________, and _____________.
5. Pig iron that is remelted and poured into a mold to make a useful product is called _________ _________.
6. Pig iron contains (many, few) impurities and has a (high, low) carbon content.
7. In an open-hearth furnace, ____________ melts and floats on top of the steel, collecting impurities and protecting the steel from the flame.
8. The large rectangular blocks of steel formed in molds from molten steel are called _________.
9. Steel wire is formed by the process called _________.
10. The steelmaking process that rapidly replaced the Bessemer process was the _________ _________ _________.
11. Cast iron is made in a furnace called a _________.
12. Working the metal to form long grains from rather large grains will (strengthen, weaken) the metal.
13. Cold forming is any forming or working of metal that is performed (above, below) the _________ temperature.
14. Two advantages of cold-rolling steel are

    a. b.

15. Generally, (ferrous, nonferrous) metals are attracted by a magnet at room temperature.
16. In a flame test (aluminum, magnesium) will burn readily.
17. The international standard of measurement of hardness is called the _____________ test.
18. An AISI-SAE description of E51100 means:

    E — _______________
    5 — _______________
    1 — _______________
    100 — _______________

19. The coefficient of electrical conductivity is usually expressed as a percent and _________ is considered as 100%.
20. _________ of a material represents its weight per unit volume.

21. Mechanical stress is usually expressed in _________ _________ _________ _________.

22. ______________ is most generally a measure of resistance to indentation, scratching, wear, or impact.

23. ______________ is a measure of the ability of a material to be hammered or rolled into thin sheets.

24. ______________ is a property of a metal which permits a permanent deformation before it fractures in tension or under torsion.

25. A spring which can be flexed millions of times under a heavy load without breaking has a high ______________ limit.

Answer the following questions by circling either T for True or F for False.

26. T F Spark testing is a common test that is used for the identification of ferrous metals but is rather unreliable.

27. T F Wrought iron can easily be cut with a chisel during a fracture test.

28. T F Low-carbon steels appear brighter when molten than the high-carbon steels.

29. T F Materials that have a high coefficient of thermal conductivity transfer heat very slowly from one part to another.

30. T F Materials that have a high coefficient of thermal expansion warp considerably during welding.

STUDENT WORKSHEET #1 — Key

Metals Questions

Fill in the blanks or circle one answer in each set of parentheses or both.

1. The material used in the blast furnace that combines the ash and iron impurities to form slag is *limestone.*
2. The first step in changing iron ore to steel takes place in a *blast furnace.*
3. The furnace for converting iron ore into pig iron is the *blast furnace.*
4. The blast furnace is charged with *ore, coke,* and *limestone.*
5. Pig iron that is remelted and poured into a mold to make a useful product is called *cast iron.*
6. Pig iron contains *many* impurities and has a *high* carbon content.
7. In an open-hearth furnace, *limestone* melts and floats on top of the steel, collecting impurities and protecting the steel from the flame.
8. The large rectangular blocks of steel formed in molds from molten steel are called *ingots.*
9. Steel wire is formed by the process called *drawing.*
10. The steelmaking process that rapidly replaced the Bessemer process was the *basic oxygen process.*
11. Cast iron is made in a furnace called a *cupola.*
12. Working the metal to form long grains from rather large grains will *strengthen* the metal.
13. Cold forming is any forming or working of metal that is performed *below* the *critical* temperature.
14. Two advantages of cold-rolling steel are

    a. *smooth finish* b. *accurate size*

15. Generally, *ferrous* metals are attracted by a magnet at room temperature.
16. In a flame test *magnesium* will burn readily.
17. The international standard of measurement of hardness is called the *Rockwell* test.
18. An AISI-SAE description of E51100 means:

    E — *Electric Furnace*
    5 — *Chromium*
    1 — *1% of alloy is Chromium*
    100 — *1.00% carbon in the steel*

19. The coefficient of electrical conductivity is usually expressed as a percent and *silver* is considered as 100%.
20. *Density* of a material represents its weight per unit volume.

21. Mechanical stress is usually expressed in *pounds per square inch.*

22. *Hardness* is most generally a measure of resistance to indentation, scratching, wear, or impact.

23. *Malleability* is a measure of the ability of a material to be hammered or rolled into thin sheets.

24. *Ductility* is a property of a metal which permits a permanent deformation before it fractures in tension or under torsion.

25. A spring which can be flexed millions of times under a heavy load without breaking has a high *endurance* limit.

Answer the following questions by circling either T for True or F for False.

26. [✓ T] F Spark testing is a common test that is used for the identification of ferrous metals but is rather unreliable.

27. [✓ T] F Wrought iron can easily be cut with a chisel during a fracture test.

28. T [✓ F] Low-carbon steels appear brighter when molten than the high-carbon steels.

29. T [✓ F] Materials that have a high coefficient of thermal conductivity transfer heat very slowly from one part to another.

30. [✓ T] F Materials that have a high coefficient of thermal expansion warp considerably during welding.

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agricultural Engineering/Mechanization

PROBLEM AREA: Designing, Building, and Maintaining Agricultural Structures

RELATED PROBLEM AREAS:

1. Applying Mathematic Skills in Agriculture (Central Core Cluster)
2. Identifying Basic Agricultural Mechanics Principles (Central Core Cluster)
3. Meeting the Environmental Requirements of Animals

PREREQUISITE PROBLEM AREA(S) None

LEVEL: Preparatory

OCCUPATIONAL TASKS ADDRESSED:

Agricultural Business and Management Cluster

Duty K: Maintaining and Constructing Structures

1. Plan building construction

STATE GOALS FOR LEARNING

In planning the instruction for this problem area, teachers can promote the development of several student learning objectives which are related to the State Goals for Learning in Mathematics. These objectives are listed on the Learning Assessment Plan forms included on the following page(s). Those learning objectives marked with an asterisk (*) are taken from the sample lists provided by the Illinois State Board of Education.

Illinois Agricultural Core Curriculum

Agricultural Education 124 Mumford Hall 1301 W. Gregory Drive University of Illinois Urbana, IL 61801

Directors: Dale A. Law, Ed.D.
Principal Investigator: Jerry D. Pepple, Ed.D
Research Assistant: Douglas L. Stockley

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Submission Date ____________
☐ Original submission ☐ Revision
Page ____ of ____

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)

COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐

District Name

City

I. LEARNING AREA *(check one)*

☐ Language Arts
☒ Mathematics
☐ Sciences
☐ Fine Arts
☐ Social Sciences
☐ Physical Development/Health

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to make and use measurements, including those of area and volume.

Contact Person: ____________
Title: ____________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
1. Perform operations with measures.					
2. Understand measurement systems, instruments, and techniques.					

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Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date ____________
☐ Original submission ☐ Revision Page ____ of ____

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☒ Mathematics ☐ Social Sciences
☐ Sciences ☐ Physical Development/Health

(Affix label or complete district information.)

COUNTY	DISTRICT	ESC

District Name

City

Contact Person: ____________
Title: ____________
Phone: (   )

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to perform the computations of addition, subtraction, multiplication, and division using whole numbers, integers, fractions, and decimals.

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
1. Translate word problem situations to mathematical expressions.					
2. Solve word problem situations that have been translated into mathematical sentences.					
3. Use computational and problem-solving skills in real-life situations with or without a calculator as appropriate.					

ISBE 41-78 (1/88)

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date ____________
☐ Original submission ☐ Revision
Page ____ of ____

(Affix label or complete district information.)
COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐
District Name
City

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☒ Mathematics ☐ Social Sciences
☐ Sciences ☐ Physical Development/Health

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to use mathematical skills to estimate, approximate, and predict outcomes and to judge reasonableness of results.

Contact Person: ____________
Title: ____________
Phone: ( )

By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:

III. LEARNING OBJECTIVES	IV. ASSESSMENT A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	V. EXPECTATIONS Percent of Students Expected to Achieve Objective
1. Know whether enough information is presented to arrive at a conclusion.					
2. Identify information that is irrelevant to a given question.					
3. Formulate a reasonable question from given information.					
4. Identify information that was used in arriving at a particular conclusion.					
5. Apply problem-solving procedures to solve or suggest a solution to a given problem.					
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ISBE 41-78 (1/86)

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agricultural Engineering/Mechanization

PROBLEM AREA: Designing, Building, and Maintaining Agricultural Structures

STUDENT LEARNING OBJECTIVES

Upon completion of their study of this problem area, students will be able to:

1. Calculate the dead loads acting on various agricultural structures.
2. Calculate the live loads acting on various agricultural structures.
3. Calculate the bending moment of beams with both distributed and concentrated loads.
4. Calculate the section modules of rectangular and circular beams.
5. Calculate the allowable unit stress on columns.
6. Calculate the allowable lateral load for common wire nails.
7. Calculate the allowable loads in withdrawal for common nails.
8. Select the proper structural member for use in various load situations for agricultural purposes.
9. Select the proper nail fastener for use in joining structural members at various loads.
10. Recognize the various loads and stresses that act upon members of agricultural structures.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agricultural Engineering/Mechanization

PROBLEM AREA: Designing, Building, and Maintaining Agricultural Structures

PROBLEMS AND QUESTIONS FOR STUDY	INSTRUCTOR'S NOTES AND REFERENCES
1. When designing a building, what types of structural loads must be considered?	
2. Explain the differences between a dead load and a live load.	
3. Where can you find the information required to calculate allowable loads?	
4. When designing a building, what types of stresses must be considered?	
5. How do you select the correct size of beam for use in an agricultural structure?	
6. How do you select the correct size of column for use in an agricultural structure?	
7. How does the "type" of wood (hardwood, softwood) affect the structural strength?	
8. Other than type of wood, what affects the strength of a structural member?	
9. How do you choose the correct nail fastener for the amount and type of load that will be placed upon the members being joined?	
10. What effect does glue have on structural strength when applied to joints in addition to other fasteners?	

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agricultural Engineering/Mechanization

PROBLEM AREA: Designing, Building, and Maintaining Agricultural Structures

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES

1. Using a machine shed with a gable roof as an example, have students calculate dead and live loads that may be applicable.
2. Using a barn with haymow or crib with overhead storage bins, determine loads and stresses. (When possible, use a student's building for the example.)
3. Invite an architect to visit the class and discuss how he or she calculates the loads and stresses that work upon a building.
4. Tour a factory that manufactures agricultural structures. Observe the design procedures as well as any premanufactured construction. Have company personnel discuss the design and manufacturing process, and indicate the company's quality control measures for assuring that materials used in construction will withstand loads and stresses.
5. Construct a wind tunnel large enough to test the wind loads on a miniature building. Demonstrate the effects of having one or more sides of the building open, varying the wind directions, and increasing wind velocities. (The tunnel can also be used to demonstrate the effects of windbreaks and topography.)
6. Demonstrate how various structural members resist loads by applying various load pressures to beams and columns. This can be accomplished in lab using both hardwoods and softwoods. Rather than using lumber of full-sized dimensions (i.e., 2" x 4"), you may wish to use 1" x 2" material or smaller.
7. Demonstrate how various structural fasteners resist loads. Both lateral and withdrawal loads should be applied to show the strength of fasteners. Include nails, bolts, glue, and other fasteners.
8. Other structural design activities should include a study of concrete (see page 23 of VAS Unit *Concrete Improvements for Farm and Home*) and grassed waterways (see Extension Circular *Design for a Grassed Waterway*).
9. For building and maintaining agricultural structures refer to Core III materials for Rural Agriculture Programs for teaching activities and procedures.
10. Build a device for testing load-bearing capacities using a hydraulic cylinder and a pressure gauge. This device could function much like a log splitter.
11. Demonstrate deflection of beams using various loads. Using boards of similar size but of several different species of wood, construct a number of beams of the different beam types. Place a constant, concentrated load upon each of these test beams and measure deflection with a dial indicator. This test, extended over a period of several days or weeks, can be used to demonstrate load durations. Have students take periodic readings over time and construct graphs and tables from this data. Experiment with beams of various shapes and wood with various known defects.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agricultural Engineering/Mechamization

PROBLEM AREA: Designing, Building, and Maintaining Agricultural Structures

REFERENCES

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*2. *Agricultural Buildings and Structures.* Whitaker, J.A. Reston/Prentice Hall, Reston, VA.

3. *Buildings for Small Acerages.* Boyd, J.A. Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

4. *Handbook of Livestock Equipment.* Juergenson, E.M. Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

5. *Carpentry.* Koel, L. American Technical Publishers, Inc., 1155 W. 175th Street, Homewood, IL 60430.

6. *Carpentry and Building Construction.* Feirer, J.L., Wilson, P. Copp Clark Pitman, Toronto, Canada.

7. *Practical Farm Buildings.* Boyd, J.S. Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

8. *Construction Principles, Materials and Methods.* Schmidt, J.L., Lewis, W.H., Olin, H.B. Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

*9. *Structures and Environment Handbook.* (Midwest Plan Service, MWPS-1). Agricultural Engineering Department, 338 Agricultural Engineering Sciences, 1304 W. Penn, University of Illinois, Urbana, IL 61801. (Numerous other publications are available. Write for a catalog.)

10. *Engineering Applications in Agriculture.* Bowers, W., Jones, B., Olver, E.F. Stipes Publishing Co., 10-12 Chester Street, Champaign, IL 61820.

11. *Design for a Grassed Waterway.* (Circular 1225). University of Illinois, Cooperative Extension Service, College of Agriculture, 69C Mumford Hall, 1301 W. Gregory Drive, Urbana, IL 61801.

12. *Concrete Improvements for Farm and Home* (VAS Unit #U3007A); *Recommended Practices for Building with Concrete Masonry* (VAS Unit #U3034); *Using the Carpenter's Square* (VAS Unit #U3009A); *Applying Asphalt Roofing and Siding* (VAS Unit #U3035); *Glazing* (VAS Unit #U3039); *Plywood Applications in Farm Construction* (VAS Unit #U3042); *Metal Roofing and Siding for Farm Structures* (VAS Unit #U3052); *Lumber: Grading, Selecting, Buying, Using, and Storing* (VAS Unit #U3055). Vocational Agriculture Service, College of Agriculture, University of Illinois, 1401 S. Maryland Drive, Urbana, IL 61801. (217) 333-3871.

*Indicates highly recommended reference

INSTRUCTOR'S NOTES AND REFERENCES

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INSTRUCTIONAL RESOURCES

These resources are intended for use by teachers in planning and teaching the materials for this problem area and may be adapted to fit the teaching method(s) used.

INFORMATION SHEET #1 — Structural Loads

INFORMATION SHEET #2 — Wind Loads on Exterior Building Surfaces

INFORMATION SHEET #3 — Examples of Wind Loads

INFORMATION SHEET #4 — Table: Live Design Loads

INFORMATION SHEET #5 — Table: Weights of Building Materials

INFORMATION SHEET #6 — Table: Unit Weight of Agricultural Products

INFORMATION SHEET #7 — Beams and Bending Moments

INFORMATION SHEET #8 — Calculating Section Modulus

INFORMATION SHEET #9 — Table: Properties of Dressed Lumber (Softwood)

INFORMATION SHEET #10 — Table: Allowable Unit Stress for Structural Lumber

INFORMATION SHEET #11 — Columns and Unit Stress

INFORMATION SHEET #12 — Using Nails as Structural Fasteners

INFORMATION SHEET #13 — Terms to be Defined

TRANSPARENCY MASTER # 1 — Basic Wind Speed

TRANSPARENCY MASTER # 2 — Snow Loads

TRANSPARENCY MASTER # 3 — Types of Beams and Loads

INFORMATION SHEET #1

Structural Loads

1. Total load — the sum of dead load and live load.

2. Dead load — the weight of the materials used to construct the building. This load is constant in amount and acts vertically downward. It is calculated by determining the weight of the building material supported by the structural members or joints.

3. Live load — the weight of snow, wind, and stored materials such as grain, hay, equipment and livestock.

   a. Snow load:

      1. Acts vertically downward on the roof of the building.
      2. Varies in intensity with the geographical location and the slope of the roof.
      3. Of 20 pounds per square foot of horizontal roof projection is used, in Illinois and states of similar latitude, for roof slopes of 20° or less.
      4. Decreases at a uniform rate, as roof slope increases, from 20 pounds at a 20° slope to 0 pounds at a 60° slope.
      5. Of 10 pounds per square foot is used to allow for freezing rain except in southern or Pacific coast states.

   b. Wind load:

      1. Acts perpendicularly to the surfaces of buildings.
      2. Includes factors such as wind velocity, height and slope of the building, and orientation of the building with respect to wind.
      3. Is based on pressure exerted by the highest average wind velocity during any five-minute interval, as reported by the U.S. Weather Bureau, plus a 50% gust.
      4. Pressure (q) is determined by the formula **$q = (0.00256)(v)^2$** where v is true wind speed.

   c. Stored product load:

      1. Always acts downward.
      2. Is sometimes also exerted horizontally outward onto the walls.
      3. Depends on the unit weight of the material. For example: How much downward pressure results from a stack of baled hay that is 20 feet wide by 40 feet long by 30 feet high? To get the answer multiply 20 feet by 40 feet by 30 feet to get a total of 24,000 cubic feet and then multiply 24,000 cubic feet by the weight per bale of 12 pounds per cubic foot to get 288,000 pounds.

INFORMATION SHEET #2

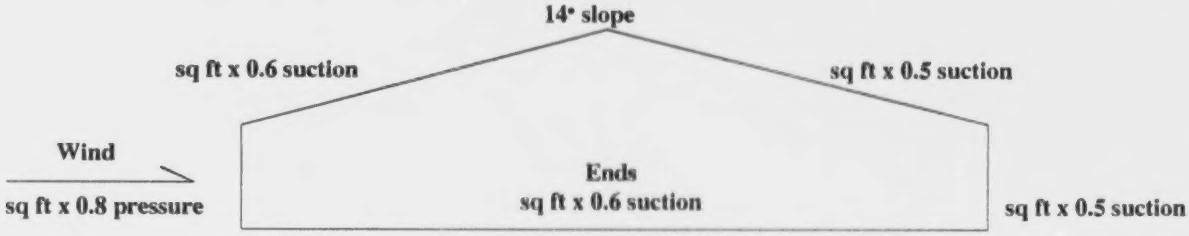
Wind Loads on Exterior Building Surfaces

Orientation	Wind Load
Windward walls, closed building	0.8 q pressure
Leeward walls, closed building	0.5 q pressure
Parallel walls, closed building	0.6 q pressure
Windward roofs, closed building	
0° to 20° slope	0.6 q suction
20° to 30° slope	0.6 to 0.0 q suction
30° to 60° slope	0.0 to 0.6 q pressure
60° and over	0.6 q pressure
Leeward roofs, closed building	
Flut	0.6 q suction
Sloped	0.5 q suction
Parallel roofs, closed building	
Any slope	0.6 q suction
30% or more wall opening/windward wall	
All walls and roof	0.7 q pressure
30% or more wall opening/leeward or parallel side	
All walls and roof	0.5 q suction

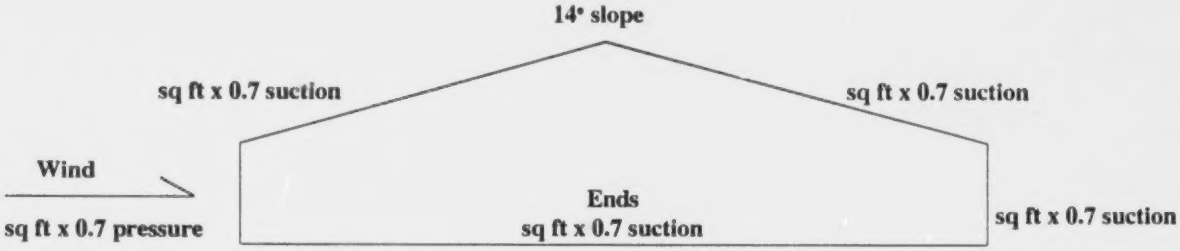
INFORMATION SHEET #3

Examples of Wind Loads

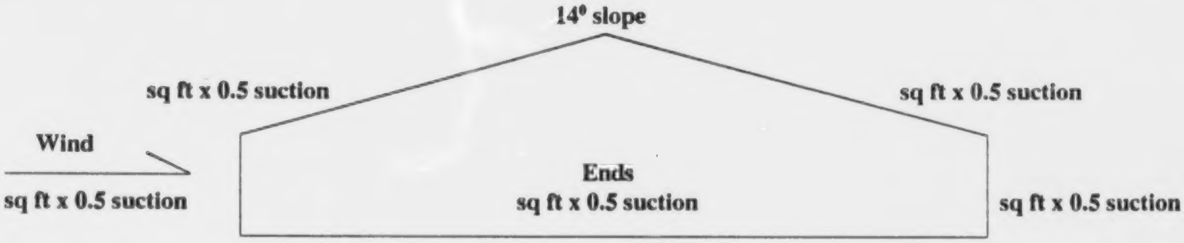
Determine the wind loads on a closed gable-roofed building that has its axis perpendicular to the wind.


14° slope
sq ft x 0.6 suction
sq ft x 0.5 suction
Wind
Ends
sq ft x 0.6 suction
sq ft x 0.8 pressure
sq ft x 0.5 suction

Determine the wind loads on a gable-roofed building that has its axis perpendicular to the wind and more than 30% of the wall on the windward side is open.


14° slope
sq ft x 0.7 suction
sq ft x 0.7 suction
Wind
Ends
sq ft x 0.7 suction
sq ft x 0.7 pressure
sq ft x 0.7 suction

Determine the wind loads on a gable-roofed building that has its axis perpendicular to the wind and more than 30% of the wall on the leeward side is open.


14° slope
sq ft x 0.5 suction
sq ft x 0.5 suction
Wind
Ends
sq ft x 0.5 suction
sq ft x 0.5 suction
sq ft x 0.5 suction

INFORMATION SHEET #4

Table: Live Design Loads

	Solid Floor lb / sq ft	Slotted Floor lb / sq ft
Cattle		
Tie stalls	70	---
Loosehousing	80	100
Young stock to 400 lbs	50	50
Sheep	30	50
Horses	100	---
Swine		
to 50 lbs	---	35
to 200 lbs	---	50
to 400 lbs	---	65
to 500 lbs	---	70
Poultry floor management	40	---
Greenhouse	50	---
Maintenance shop	70	---
Machinery storage	150	minimum, may be much greater depending on weight per wheel for vehicles

INFORMATION SHEET #5

Table: Weights of Building Materials

Material	lb / cubic ft	lb / square ft
Concrete	150	---
Steel	490	---
Oak 1"	45	3.5
Yellow pine 1"	39	3.0
Douglas fir 1"	34	2.5
Soft pine 1"	30	2.2
Eastern spruce 1"	34	---
Plywood 3/8"	---	1.1
Plywood 1/2"	---	1.5
Plywood 5/8"	---	1.8
Aluminum roofing	---	0.4
Galvanized roofing	---	0.8
Asphalt shingles	---	2.2 to 3.2
Asphalt selvage roll	---	1.5
Asphalt roll roofing		0.5 to 1.0
Wood shingles		2.0
Concrete block wall 4"		30
Concrete block wall 8"		57
Concrete block wall 12"		80
Brick wall 4"		37
Brick wall 8"		79
Glass block		20

INFORMATION SHEET #6

Table: Unit Weight of Agricultural Products

Product	Whole		Ground	
	lb / bu	lb / ft3	lb / bu	lb / ft3
Wheat	60	48	50	43
Barley	48	38.4	37	28
Oats	32	25.6	23	18
Rye	56	44.8	48	38
Corn, shelled (dry)	56	44.8	48	38
Corn, ear (dry)	70	28.0	45	36
Grain sorghum	56	44.8	42.5	34
Soybeans	60	48	37.5	30
Soybean oil meal	---	---	42	36
Linseed oil meal	---	---	40	32
Cottonseed oil meal	---	---	47.5	38
Alfalfa meal	---	---	22.5	18
Alfalfa pellets	55.5	42	---	---
Wheat bran	---	---	17.5	14
Molasses feed	---	---	28.7	23
Salt	85	68	---	---
Hay, baled	---	12	---	---
Hay, chopped	---	8 to 10	---	---
Fescue seed	14 to 30	11 to 24	---	---
Clover seed	60	48	---	---
Apples	54 / box	---	---	---
Peanuts, unshelled	17	13.6	---	---
Potatoes	60	---	---	---
Corn silage	---	40 to 50	---	---

INFORMATION SHEET #7

Beams and Bending Moments

Beams are structural members that are loaded by forces acting perpendicular to their axis. There are three types:

1. Simple — supported at each end without a rigid connection.
2. Cantilever — supported solidly at one end.
3. Continuous — supported at several points along its span without rigid connection.

Bending moment is a measure of stresses acting on the beam, calculated according to the type of beam and how the load is distributed. The formulas are:

	Load	
	Concentrated	**Distributed**
1. Simple beam	m = 1/4 W L (center load)	m = 1/8 W L
2. Cantilever beam	m = W L (end load)	m = 1/2 W L
3. Continuous beam	m = 1/6 W L (center loaded)	m = 1/12 W L

KEY
m = bending moment
W = total weight in pounds
L = length in inches

Examples: Find the bending moment of:

1. A 10-foot simple beam with a uniform load of 240 pounds per foot of length.
   W = 240 lb/ ft x 10 ft = 2400 lb
   m = 1/8 W L
   m = (2400 lb x 10 ft x 12 in / ft) ÷ 8 = 36,000 in-lb

2. A 10-foot simple beam with 2,400 pounds at the center of the beam.
   W = 2400 lb
   m = 1/4 W L
   m = (2400 lb x 10 ft x 12 in / ft) ÷ 4 = 72,000 in-lb

3. A 10-foot cantilever beam with a uniform load of 240 pounds per foot of length.
   W = 240 lb / ft x 10 ft = 2400 lbs
   m = 1/2 W L
   m = (2400 lb x 10 ft x 12 in / ft) ÷ 2 = 144,000 in-lb

4. A 10-foot cantilever beam with a concentrated load of 2,400 pounds at the end of the beam.
   W = 2400 lb
   m = W L
   m = 2400 lb x 10 ft x 12 in / ft = 288,000 in-lb

INFORMATION SHEET #8

Calculating Section Modulus

Section modulus is a measure of the ability of a cross-sectional area to resist bending moment. We use the following symbols:

$z = m/f$
where
z is the section modulus in cubic inches
m is the bending moment in inch-pounds
f is the allowable fiber stress in bending, pounds per square inch (psi) (see Information Sheet #10)

Section modulus varies with the dimensions of the beam and the orientation of the dimensions to the load. For example:

1. Rectangular beam

   $z = 1/6\ b\ d^2$
   where
   z = section modulus
   b = width in inches
   d = depth in inches

2. Circular beam

   $z = 0.1\ d^3$
   where
   z = section modulus
   d = depth in inches (diameter)

Example:

1. An overhead grain bin is to hold soybeans to a depth of 10 feet. Southern pine joists 10 feet long will support the bin. What size of 2" beams placed on 12" centers should be used? For a solution we have:

   W = 10 ft x 10 ft x 1 ft x 48 lb/cubic ft = 4,800 lb
   $m = 1/8\ W\ L$ = (4,800 lb x 10 ft x 12 in/ft) + 8 = 72,000 in-lb
   $z = m/f$ = 72,000 in-lb + 2010 lb/square in = 35.82 cubic in
   $z = 1/6\ b\ d^2$ = 1/6 x 2 in x $(10\ \text{in})^2$ = 33.33 cubic in (33.33 cubic in is not ≥ 35.82 cubic in)
   $z = 1/6\ b\ d^2$ = 1/6 x 2" x $(12\ \text{in})^2$ = 48 cubic in (48 cubic in is ≥ 35.82 cubic in)

Thus, a 2" x 10" joist (actual size) does not have a sufficient section modulus for the purposes of this example. A 2" x 12" joist would have a section modulus that exceeds the example requirements. That computation is left as an exercise.

INFORMATION SHEET #9

Table: Properties of Dressed Lumber (Softwood)

Nominal Size (in)	Actual Size b (in)	d	Area (b x d) (in^2)	Weight * (lb / ft)	Dressed Section Modulus ** (in^3)
2 x 4	1.50	3.50	5.25	1.094	3.0625
2 x 6	1.50	5.50	8.25	1.719	7.5625
2 x 8	1.50	7.25	10.875	2.266	13.1406
2 x 10	1.50	9.25	13.875	2.891	21.3906
2 x 12	1.50	11.25	16.875	3.519	31.6406
2 x 14	1.50	13.25	19.875	4.141	43.8910
3 x 4	2.50	3.50	8.75	1.823	5.1042
4 x 4	3.50	3.50	12.25	2.552	7.1458
4 x 6	3.50	5.50	19.25	4.010	17.6458
4 x 8	3.50	7.25	25.375	5.286	30.6615
6 x 6	5.50	5.50	30.25	6.302	27.7292
6 x 8	5.50	7.25	39.8750	8.594	48.1823
6 x 10	5.50	9.25	50.8750	10.885	78.7323
8 x 8	7.25	7.25	52.5625	11.719	63.5130
10 x 10	9.25	9.25	85.5625	18.802	131.9089

* Weight of softwood will be considered to be 30 lbs per ft^3 for the purposes of this table.
Weight = Area x 30 lb/ft^3
Weight (lb/ft) = [bd in^2 x ft^2/144 in^2] x 30 lb/ft^3
Weight (lb/ft) = (bd + 144) x 30

** 1/6 bd^2

INFORMATION SHEET #10

Table: Allowable Unit Stress for Structural Lumber

				Allowable unit stresses, lb/in²						
						Tension	Horiz	Compression		Modulus of
Species		Size		Bending, F_b		parallel	shear	Perp	Parallel	elasticity
Use	Grade	Thick	Wide	Engr	Repeat	F_t	F_v	$F_{c\perp}$	F_c	E
For lumber milled and used at 15% m.c., multiply stress by:				1.08	1.08	1.08	1.05	1.00	1.17	1.05
Douglas fir-larch (used at 19% m.c.; West Coast Lumber Inspection Bureau)										
Struct light framing	Select struct	2" - 4"	2" - 4"	2100	2400	1200	95	625	1600	1,800,000
	No.1			1750	2050	1050	95	625	1250	1,800,000
	No.2			1450	1650	850	95	625	1000	1,700,000
Light framing	Const.	2" - 4"	4"	1050	1200	625	95	625	1150	1,500,000
	Stand			600	675	350	95	625	925	1,500,000
	Utility			275	325	175	95	625	600	1,500,000
Joist & plank	Select struct	2" - 4"	5" and wider	1800	2050		95	625	1400	1,800,000
	No.1			1500	1725		95	625	1250	1,800,000
	No.2			1250	1450		95	625	1050	1,700,000
	Stud		5" & 6"	725	850		95	625	675	1,500,000
Posts & timbers	Select struct	5" or larger	Thick +2" and smaller	1500		1000	85	625	1150	1,600,000
	No.1			1200		825	85	625	1000	1,600,000
Beams & stringers	Select struct	5" or larger	Greater than thick + 2"	1600		950	85	625	1100	1,600,000
	No.1			1350		675	85	625	925	1,600,000
Southern Pine (used at 19% m.c.; Southern Pine Inspection Bureau)										
Struct light framing	Select struct	2" - 4"	2" - 4"	2000	2300	1150	100	565	1550	1,700,000
	No.1.			1700	1950	1000	100	565	1250	1,700,000
	No.2			1400	1650	825	90	565	975	1,600,000
	Stud			775	900	450	90	565	575	1,400,000
Light framing	Const.	2" - 4"	4"	1000	1150	600	100	565	1100	1,400,000
	Stand			575	675	350	90	565	900	1,400,000
	Utility			275	300	150	90	565	575	1,400,000
Struct joist & plank	Select struct	2" - 4"	5" and wider	1750	2010		90	565	1350	1,700,000
	No.1			1450	1700		90	565	1250	1,700,000
	No.2			1200	1400		90	565	1000	1,600,000
	Stud		5" & 6"	725	850		90	565	625	1,400,000
Stress rated timber	No.1 SR	5" x 5" and larger		1350	1350	875	110	325	775	1,500,000
	No.2 SR			1100	1100	725	95	325	625	1,400,000

Source: Design Values for Wood Construction, Natural Forest Products Association.

INFORMATION SHEET #11

Columns and Unit Stress

A column is a vertical members loaded parallel to its axis. The allowable unit stress (compression parallel to the grain) in a simple solid column is determined by:

$P = c_{adj} A$

$c_{adj} = 0.30\ E + (L / d)^2$

where

P is the total load in lbs

c_{adj} is compressive stress parallel to grain for a type of wood, in psi (adjusted for length of column)

E is the modulus of elasticity, in psi, and is a constant in bending which expresses the ratio of unit stress to unit deformation

L is the length of the column in inches

d is the least dimension of the column in inches

A is the Area of the column calculated by $(d)^2$

Note: A safe load on a round column is 0.785 times the safe load on a square column with side measurement equal to the diameter of the round column.

Example:

Determine the load that can be carried by a dressed 4" x 4" (actual 3.5" x 3.5") wooden column 10 feet long. The safe stress in compression parallel to grain is 1500 psi, and the modulus of elasticity is 1,600,000 psi.

1. Compute $c_{adj} = 0.30\ E + (L / d)^2 = (0.30 \times 1{,}600{,}000 \text{ psi}) + (120 \text{ inches} + 13.5 \text{ inches})^2 = 408 \text{ psi}$

Note: c_{adj} = 408 psi is less than F_c = 1550 psi from F_c column on Information Sheet #10.

2. $P = c_{adj} \times A = 408 \text{ psi} \times 12.25 \text{ square inches} = 4998 \text{ lb}$ safe load.

INFORMATION SHEET #12

Using Nails as Structural Fasteners

The larger the diameter of the nail and the greater the length of penetration, the greater its resistance to load. Also, the higher the specific gravity and the lower the moisture content, the stronger the piece of lumber.

Nails may be loaded either laterally or in withdrawal. When the load acts perpendicularly to the length of the nail, the nail is loaded laterally. When the load is applied in such a way that it tends to pull the nail out of the piece receiving the point, the nail is loaded in withdrawal.

Table for allowable lateral loads for common wire nails

		Allowable lateral load, lb/nail	
Pennyweight ("d")	Length (in)	Softwoods	Hardwoods
6	2	94	117
8	2 1/2	117	145
10	3	141	174
12	3 1/4	141	174
16	3 1/2	160	199
20	4	208	258
30	4 1/2	232	288
40	5	264	327
50	5 1/2	298	369
60	6	334	412

These loads apply when the nails are driven into the side grain of seasoned wood and when penetration into the block receiving the point is not less than 2/3 of the length of the nail for softwoods and 1/4 of the length of the nail for hardwoods. Allowable loads for unseasoned wood are 3/4 of those for seasoned wood. Allowable loads for nails driven into end grain are 2/3 of those for nails driven into side grain. In a toe-nailed joint, the allowable lateral load per nail is 5/6 of that for nails in the side grain.

Table for allowable lateral loads for common wire nails

	Allowable load in withdrawal, lb/in penetration		
Pennyweight ("d")	Douglas Fir (Softwood)	Southern Pine (Softwood)	Oak (Hardwood)
6	43	63	82
8	51	72	96
10	57	82	108
12	57	82	108
16	63	90	118
20	73	106	141
30	79	114	151
40	87	124	165
50	94	135	178
60	102	145	192

These loads apply when the nails are driven into the side grain of seasoned wood. Allowable loads for unseasoned woods that season under load are 1/4 of those for seasoned wood. In a toe-nailed joint, the allowable withdrawal load is 2/3 of that for nails in the side grain.

Example:

A 2" x 4" board is nailed to a well seasoned 4" x 4" fir post with four 30d spikes. What loads can this fastening carry?

1. Determine required penetration.
    a. 30d is 4 1/2 inches long
    b. 1/2 x 9/2 = 9/4 = 2 1/2" minimum hardwood
    c. 2/3 x 9/2 = 9/3 = 3" minimum softwood
2. Determine the length of the nails remaining after passing through a 2" x 4" board.
    a. 4 1/2" - 1 1/2" = 3" available to drive into post. (This meets required penetration.)
    b. Lateral load is 232 lb/nail.
    c. 232 x 4 (nails) = 928 lb load
    d. Withdrawel load is 70 lb/in/nail.
    e. 79 x 3 x 4 = 948 lb load

INFORMATION SHEET #13

Terms to be Defined

Beam — a structural member which is subjected to loads that are primarily perpendicular to the long axis. Beams such as floor joints are ordinarily installed horizontally, but they may be inclined as in the case of a rafter.

Bending moment — the algebraic sum of the moments of all loads and reaction to the left or to the right of a given cross section. An example would be a measure of stresses acting on a beam expressed in pounds.

Column — a structural member which is subjected to loads that are primarily parallel to the long axis. Ordinarily columns are installed vertically, such as a post under a beam.

Compression — those stresses tending to press an object together.

Dead load — the weight of the materials used to construct a structure. It is usually constant in amount and acts vertically downward.

Hardwood — certain species of trees and their wood. Hardwoods have broad leaves and are deciduous (shed their leaves each season). It is not a description of the wood's hardness or softness.

Leeward — the direction opposite that from which the wind is blowing.

Live load — the sum of the weight of stored products, equipment, livestock, and vehicles. Also included are snow load, wind, and earthquake, although they are generally treated separately.

Modulus of elasticity (E) — a measure of the stiffness of the material. A factor used to determine the amount of deflection when a load is applied expressed in pounds per square inch.

Moment — a measure of the tendency to produce motion about a point on an axis.

Safe fiber stress (f) — a measure of the strength characteristics of a material to resist failure due to various stresses, expressed in pounds per square inch.

Section modulus — a measure of the ability of a cross-sectional area to resist bending moment; a measure of beam strength expressed in cubic inches.

Shear — those stresses tending to cause parts of a material to slide in relation to each other.

Softwood — certain species of trees and their wood. Softwoods are conifers and have scalelike leaves as in cedars or needlelike leaves as in pines. It is not a description of the wood's hardness or softness.

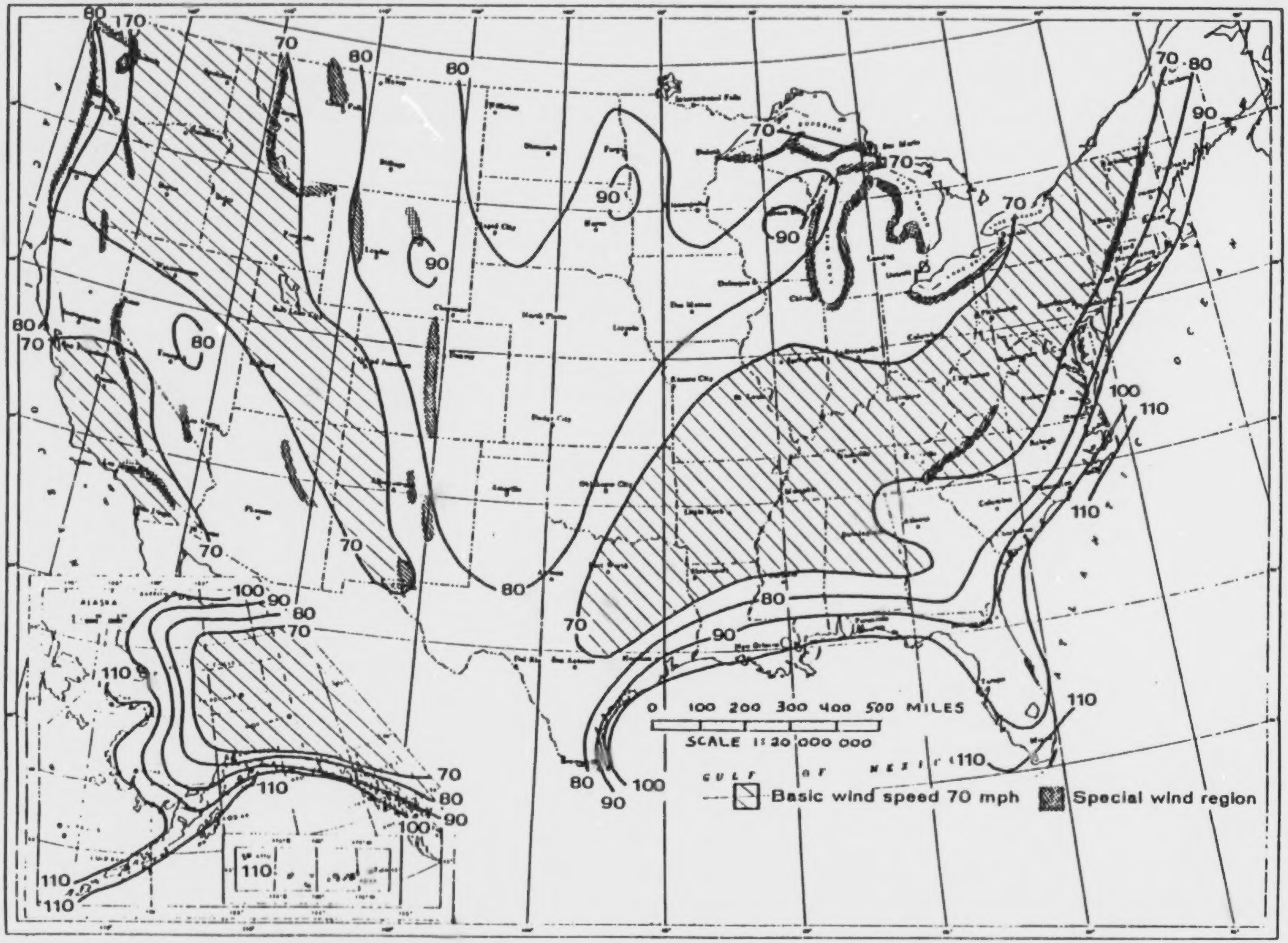
Stress — the internal resistance of a member to external loads. In other words, stress is not the loads applied to the member, but rather the forces inside the member that hold up or resist the loads. There are three basic types of stress: tension, compression, and shear.

Tensile — those stresses tending to pull an object in half or apart.

Ultimate strength — the maximum strength of a structural member, determined by laboratory tests that determine the amount of stress that will cause failure.

Windward — the direction from which the wind is blowing.

TRANSPARENCY MASTER #1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90
100
110
0 100 200 300 400 500 MILES
SCALE 1:20 000 000
GULF OF MEXICO
▨ Basic wind speed 70 mph
▩ Special wind region

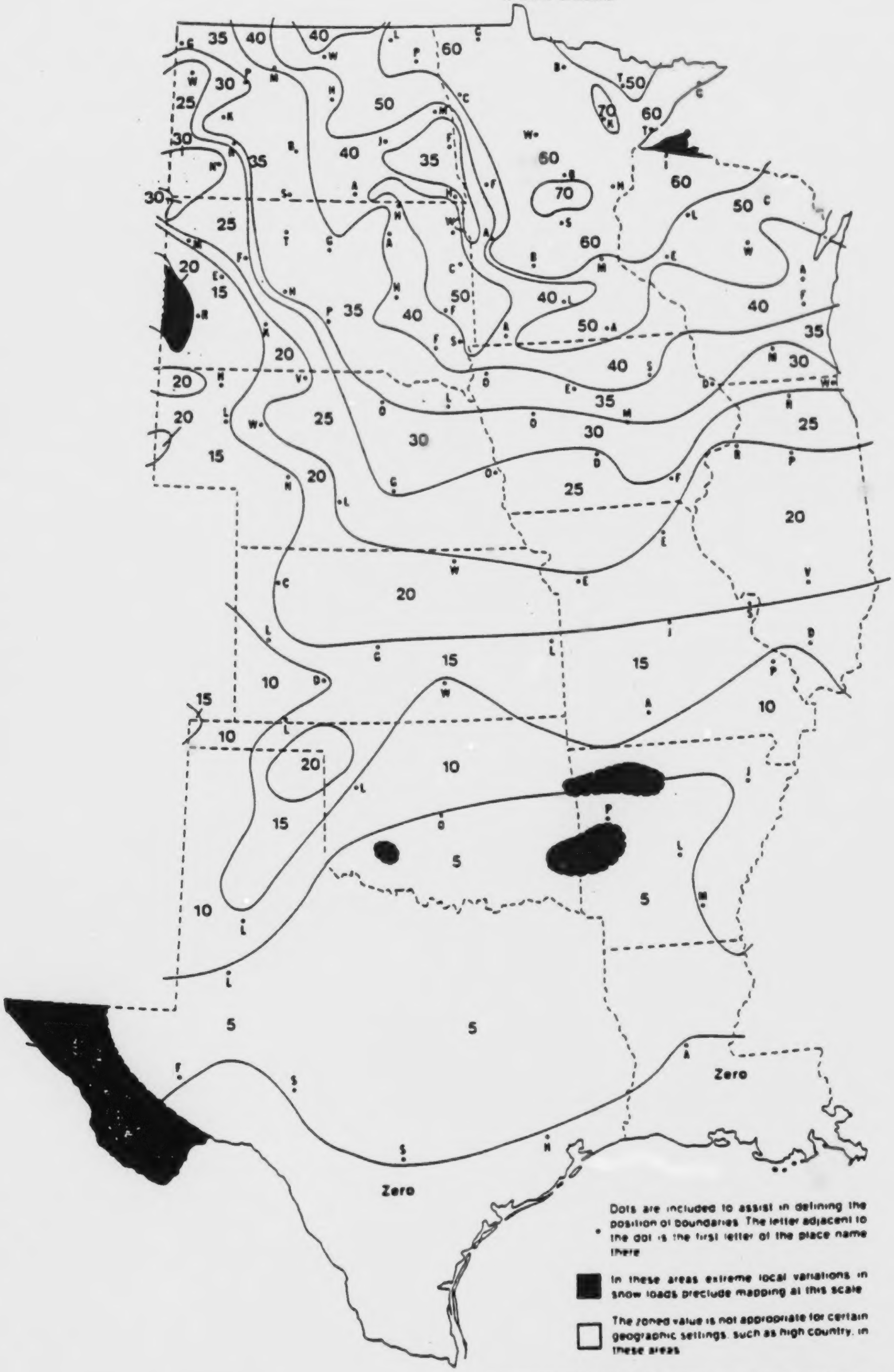
Basic wind speed, mph.

Values are fastest-mile speeds at 33' above ground for rural exposure and an annual probability of 0.02 (50-yr recurrence interval).

Linear interpolation between wind speed contours is acceptable. Use caution with wind speed contours in mountainous regions of Alaska.

TRANSPARENCY MASTER #2

Snow Loads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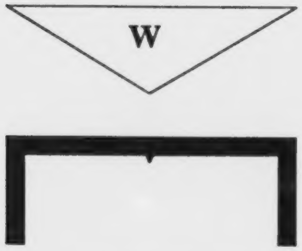
Zero
Dots are included to assist in defining the position of boundaries. The letter adjacent to the dot is the first letter of the place name there.
■ In these areas extreme local variations in snow loads preclude mapping at this scale.
☐ The zoned value is not appropriate for certain geographic settings, such as high country, in these areas.

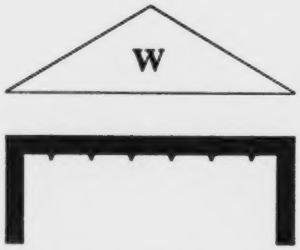
Values are loads associated with an annual probability of 0.02 (50-yr recurrence interval).

TRANSPARENCY MASTER #3

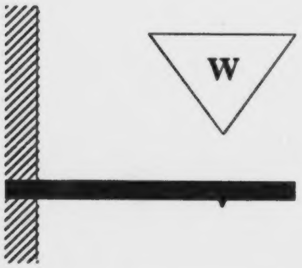
Types of Beams and Loads



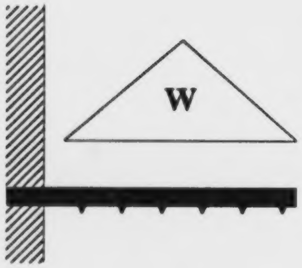
Simple Beam Concentrated Load



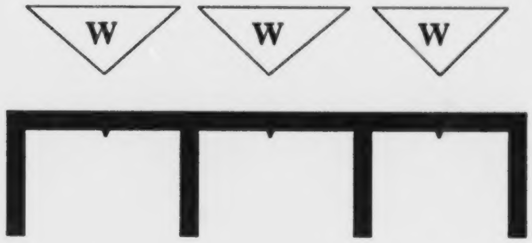
Simple Beam Distributed Load



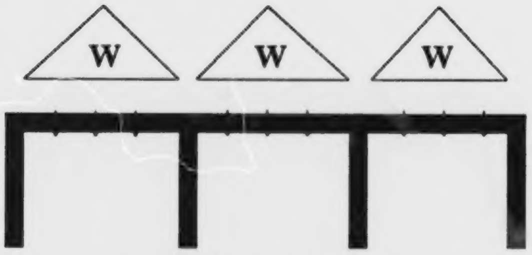
Cantilever Beam Concentrated Load



Cantilever Beam Distributed Load



Continuous Beam Concentrated Load



Continuous Beam Distributed Load

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agricultural Engineering/Mechanization

PROBLEM AREA: Repairing and Maintaining Agricultural Equipment

RELATED PROBLEM AREAS:

1. Developing Communication Skills in Agriculture (Central Core Cluster)
2. Applying Mathematics Skills in Agriculture (Central Core Cluster)
3. Keeping and Using Records in Agriculture (Central Core Cluster)
4. Advertising and Selling Agricultural Products and Services
5. Manufacturing, Distributing, Selling, and Servicing Agricultural Equipment

PREREQUISITE PROBLEM AREA(S):

1. Developing Communication Skills in Agriculture (Central Core Cluster)
2. Applying Mathematics in Agriculture (Central Core Cluster)

LEVEL: Preparatory

OCCUPATIONAL TASKS ADDRESSED:

Agricultural Business and Management Cluster

Duty B: Performing Sales Duties

1. Determine customer needs
2. Compute sales tax
3. Complete sales slip
4. Inform customer of warranty and guarantee specifications
5. Complete business forms
6. Communicate orally with clients
7. Compute markup

Duty C: Performing Sales-Related Duties

1. Process customer complaints
2. Supply parts to service shop
3. Use microfiche to determine part number
4. Use parts catalog to determine part number
5. Use computer inventory system to determine part availability

STATE GOALS FOR LEARNING

In planning the instruction for this problem area, teachers can promote the development of several student learning objectives which are related to the State Goals for Learning in Mathematics and Language Arts. These objectives are listed on the Learning Assessment Plan forms included on the following page(s). Those learning objectives marked with an asterisk (*) are taken from the sample lists provided by the Illinois State Board of Education.

Illinois Agricultural Core Curriculum

Agricultural Education 124 Mumford Hall 1301 W. Gregory Drive University of Illinois Urbana, IL 61801

Director: Dale A. Law, Ed.D.
Principal Investigator: Jerry D. Pepple, Ed.D.
Research Assistant: Douglas L. Stockley

Illinois Agricultural Core Curriculum Rev.

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date ____________
☐ Original submission ☐ Revision
Page ____ of ____

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☒ Mathematics ☐ Social Sciences
☐ Sciences ☐ Physical Development/Health

(Affix label or complete district information.)
COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐
District Name
City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to perform the computations of addition, subtraction, multiplication, and division using whole numbers, integers, fractions and decimals.

Contact Person: ____________
Title: ____________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Use computational and problem-solving skills in real-life situations with or without a calculator as appropriate.					
*2. Schedule and budget their time.					
1553					1554

ISBE 41-78 (1/86)

Agricultural Business and Management
Agricultural Engineering/Mechanization

Repairing and Maintaining Agricultural Equipment

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date ____________
☐ Original submission ☐ Revision
Page ____ of ____

I. LEARNING AREA *(check one)*
☐ Language Arts
☒ Mathematics
☐ Sciences
☐ Fine Arts
☐ Social Sciences
☐ Physical Development/Health

(Affix label or complete district information.)

COUNTY	DISTRICT	ESC

District Name

City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to understand and use ratios and percentages.

Contact Person: ____________
Title: ____________
Phone: ( )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Solve problems involving discounts, sales tax, and commissions.					
*2. Apply rates and percents in real-life situations.					

ISBE 41-78 (1/86)

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date ____________
☐ Original submission ☐ Revision
Page ____ of ____

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☒ Mathematics ☐ Social Sciences
☐ Sciences ☐ Physical Development/Health

(Affix label or complete district information.)

COUNTY	DISTRICT	ESC

District Name

City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to make and use measurements, including those of area and volume.

Contact Person: ____________
Title: ____________
Phone: ( )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Understand measurement systems, instruments, and techniques. (Those systems and instruments related to time measurement apply in this problem area.)					
2. Convert standard time to military time.					
					1558
1557					

ISBE 41-78 (1/88)

Agricultural Business and Management
Agricultural Engineering/Mechanization

Repairing and Maintaining Agricultural Equipment

Submission Date ____________
☐ Original submission ☐ Revision
Page ____ of ____

I. LEARNING AREA *(check one)*
☒ Language Arts
☐ Mathematics
☐ Sciences
☐ Fine Arts
☐ Social Sciences
☐ Physical Development/Health

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)
COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐
District Name
City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to listen critically and analytically.

Contact Person: ____________
Title: ____________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
•1. Evaluate the content of an oral message of an appropriate length.					
•2. Judge the sufficiency of detail, the qualifications and credibility of sources, and the effectiveness of solutions proposed in oral messages.					
•3. Evaluate the implications of verbal and nonverbal cues in oral presentations.					
•4. Distinguish among differing perspectives and points of view.					
•5. Respond effectively and appropriately to oral messages.					
1559					1560

ISBE 41-78 (1/88)

Illinois Agricultural Core Curriculum Rev.

Repairing and Maintaining Agricultural Equipment

Agricultural Business and Management
Agricultural Engineering/Mechanization

Illinois Agricultural Core Curriculum Rev.

Submission Date ____________________

☐ Original submission ☐ Revision

Page _____ of _____

ILLINOIS STATE BOARD OF EDUCATION
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Springfield, Illinois 62777-0001

(Affix label or complete district information.)

COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐

District Name

City

I. LEARNING AREA *(check one)*

☒ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☐ Sciences ☐ Physical Development/Health

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to use spoken language effectively in formal and informal situations to communicate ideas and information and to ask and answer questions.

Contact Person: ____________________

Title: ____________________

Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Demonstrate proficiency in extemporaneous and impromtu speaking.					
*2. Develop ideas for an oral message through the use of appropriate support materials.					
*3. Organize ideas in an oral message.					
1561					1562

Repairing and Maintaining Agricultural Equipment

Agricultural Business and Management
Agricultural Engineering/Mechanization

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agricultural Engineering/Mechanization

PROBLEM AREA: Repairing and Maintaining Agricultural Equipment

STUDENT LEARNING OBJECTIVES

Upon completion of their study of this problem area, students will be able to:

1. Use a parts catalog to identify machinery parts by name and part number.
2. Use a price list to determine net price and list price given a part description and/or part number.
3. Identify the parts of a repair order form and be able to complete one.
4. Complete a time ticket and calculate a labor charge.
5. Use a flat rate schedule to estimate labor charges and calculate warranty work charges.
6. Determine items that are exempt from sales tax charges.
7. Calculate the percent markup on machinery parts.
8. Use a microfiche machine to find parts information.
9. Compute a service charge for shop work.
10. Understand how to handle a customer complaint.
11. Communicate orally with a customer providing him or her with information about servicing and operating a machine.
12. Demonstrate service and operation procedures and techniques to a customer.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agricultural Engineering/Mechanization

PROBLEM AREA: Repairing and Maintaining Agricultural Equipment

PROBLEMS AND QUESTIONS FOR STUDY **INSTRUCTOR'S NOTES AND REFERENCES**

1. What information does a parts catalog contain?
2. When given only a description of a part, what procedure is used to identify the part name and number?
3. What is the purpose of price markup?
4. When given a part description, what procedure is used to find its list price?
5. When given a reference number that contains "net price," how do you read the "net price"?
6. Other than working on equipment, what responsibilities do the service manager and service technician have?
7. With all of the equipment being worked on and all of the different mechanics working, how is the labor charge figured for each piece of equipment and the salary computed for each worker?
8. What is the purpose of a repair order form?
9. What are the parts of a repair order form?
10. Explain the process used in filling out each section of a repair order form.
11. What is sales tax?
12. How do you know when to charge sales tax?
13. What is a flat-rate charge?
14 Where can you obtain flat-rate information?
15. What should and should not be done when dealing with a customer who has a complaint?
16. Why is it important that a service manager or service technician have good communication and math skills?

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agricultural Engineering/Mechanization

PROBLEM AREA: Repairing and Maintaining Agricultural Equipment

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES

1. Invite a service manager and service technician from a local agricultural equipment dealership to speak with your class. Ask that they each first give their job description and explain their various duties. Next, ask that they explain in some detail, the specific duties involving paperwork, work with computer and microfiche machines, and communication with customers. Appropriate examples of forms along with actual experiences should be shared with the class. It is important that students learn that the service technician must have reading, writing, communication, and math skills in order to perform his or her job.

2. In order to learn about calculating a service or labor charge, have students keep accurate labor records on their own shop projects. An accurate wall clock and time sheets are all that are required. However, you may be able to purchase a new or used time clock and have students "punch in" at the beginning of each job and "punch out" at its completion. Students need to become aware of time management and efficient use of their time while in the shop. It is understandable that the first time a student performs a job it may take an inordinate amount of time. However, after a job has been performed several times a noticeable decrease in the time required for completion should occur. From these time cards students should be able to calculate the amount of time required to complete a project. Also by placing a value on their labor they should be able to calculate a labor charge. Students should be encouraged to compare labor charges on similar projects completed by other students as well as actual labor and associated charges for the same work performed in a business. Also, comparisons should be made to flat-rate charges where applicable.

3. When working on machinery or equipment in the shop, try to have a parts catalog for each machine that is being serviced or repaired. When a particular part is in need of replacement, have the student find the part number, key number, and correct name in the parts catalog. Also, if possible, students should be exposed to the microfiche machine and its use in finding parts information. Some school libraries use microfiche machines and a class assignment could be designed to use that machine. Contact local dealerships for old or duplicate copies of microfiche parts catalogs.

4. It is important that students learn that a business must make a profit in order to pay its employees and to keep functioning. Try to obtain an old price list from an agriculture machine dealership. Have the students practice totaling list prices as well as determining and totaling net prices. From the list price and net price, students should be able to calculate the percent markup that the business is making. Some dealerships have a higher markup than others and some parts have a higher markup than others. Discuss the reasons why this happens.

5. Have your class perform an informal survey of shop charges in and around your school district. From this information, have students determine an average service charge for your area. Discuss the reasons why some dealerships have a higher service charge per hour than others.

6. Have your class obtain current repair order forms from local equipment dealerships. Compare and contrast the similarities and differences between the various forms. Using a standardized form or one of those obtained locally, have students become familiar with its various parts by giving them hypothetical or actual information and have them complete the form. This exercise may involve several steps. Students may be required to look up part numbers, descriptions of parts, prices, and flat-rate hours, and to calculate sales tax. Also, labor charges can be determined from a time ticket record.

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agricultural Engineering/Mechanization

PROBLEM AREA: Repairing and Maintaining Agricultural Equipment

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES (con't.)

7. You may use a standardized repair order form for machinery and equipment that you repair or service in your school shop. Each student that brings in work or is assigned work should be able to initiate and complete a shop repair order form recording all pertinent information.

8. In a real world situation, the service manager or service technician at the agriculture machinery dealership must be able to properly handle customer complaints. One way that this might be demonstrated is to arrange for a local farmer, that you know fairly well, to bring in a tractor or piece of equipment for some repair work. Assign the work to several students and make sure that the entire class is aware of the work being done. In the meantime, meet with the farmer and coach him or her on being a customer with a complaint. Rehearse the demonstration privately and arrange for the farmer to appear (unannounced of course) during shop time as a customer with a complaint. This could be on the day that the machine is scheduled to be done and ready for pickup. Following the surprise customer complaint demonstration, review what just happened with the students. Discuss the procedure that was used or should have been used to handle the customer complaint.

9. In order to have students practice handling a customer complaint, you can use several approaches. One way is to have the instructor play the role of the customer with a complaint and have individual students play the role of the service manager or service technician. It is not only beneficial for students to see how they do this job of handling a customer complaint correctly, but also to see their own mistakes in doing the job. If time and equipment are available, make a video recording of this role playing exercise and review it with the students. Another way that this may be done is to have students play both roles and have the teacher remain an impartial moderator to keep the players on the right track.

10. When delivering a new or used piece of equipment, the delivery person must be able to communicate service and operation information to its owner. Contact local agriculture machinery dealerships and request copies of "delivery service" checksheets for new pieces of equipment. These sheets may be used for several purposes. However, the main concern here is to have the students be able to effectively communicate and demonstrate service and operation information.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agricultural Engineering/Mechanization

PROBLEM AREA: Repairing and Maintaining Agricultural Equipment

REFERENCES

INSTRUCTOR'S NOTES AND REFERENCES

*1. *Business Practices for Agricultural Machinery Dealers*. Vol 1, *Introduction and Supplement;* Vol 2, Part I, *Parts Department;* Vol 3, Part II, *Shop Services;* Vol 4, Part III, *Equipment Sales;* Vol 5, *Teacher's Guide*. (1979). Agricultural Education Curriculum Materials Service, Room 254, 2120 Fyffe Road, The Ohio State University, Columbus, OH 43210.

2. *Argi Selling*. (1983). Downey, W.D., Jackson, M.A., Stevens, C.G. Agri Business Publications, Division of Century Communications, Skokie, IL.

3. *Cost of Doing Business*. (1988). North American Equipment Dealers Association, St. Louis, MO.

4. *I & T Shop Service Flat Rate Manual.* Technical Publications Division, Intertec Publishing Corporation, Overland Park, KS.

5. Refer to Information Sheet #1, "Resource Materials List," for the names and addresses of government agencies and private companies that can provide additional resources relevant to this problem area.

*Indicates highly recommended reference

INSTRUCTIONAL RESOURCES

These resources are intended for use by teachers in planning and teaching the materials for this problem area and may be adapted to fit the teaching method(s) used.

INFORMATION SHEET #1 — Resource Materials List

INFORMATION SHEET #2 — Using the Parts Catalog

INFORMATION SHEET #3 — Using the Price List

INFORMATION SHEET #4 — Keeping Accurate Labor Records

INFORMATION SHEET #5 — The Shop Service Charge

INFORMATION SHEET #6 — The Flat Rate Charging Method

INFORMATION SHEET #7 — Calculating Flat Rate Charges

INFORMATION SHEET #8 — The Shop Repair Order

INFORMATION SHEET #9 — Handling Customer Complaints

INFORMATION SHEET #10 — Pre-Delivery and Delivery Service

TRANSPARENCY MASTER #1 — Work Order Flow Chart (Write-up Phase)

TRANSPARENCY MASTER #2 — Work Order Flow Chart (Work Period Phase)

TRANSPARENCY MASTER #3 — Work Order Flow Chart (Billing and Accounting Phase)

TRANSPARENCY MASTER #4 — Shop Repair Order

INFORMATION SHEET #1

Resource Materials List

1. **Sales Tax Information**

Illinois Department of Revenue
P.O. Box 19010
Springfield, IL 62794-9010
(800) 732-8866

2. **Business Forms**

Illinois Retail Farm Equipment Association
(IRFEA)
P.O. Box 1227
Peoria, IL 61654
(309) 688-6676

3. **Videotapes**

MFTV Service Center
1901 Bell Ave., Suite 10
Des Moines, IA 50315

The following service management tapes are available:

MF Customer Service: No Big Deal
The Work Order, "Stopping Shop Leaks"
Service Management: Servicing for Profit
Warranty Procedures

4. **Related Resources (Miscellaneous Forms, Price Lists, etc.)**

Massey-Ferguson
P.O. Box 1813
1901 Bell Ave.
Des Moines, IA 50315
(913) 621-4040

John Deere Distribution Service Center
Service Publications, Department SP
1400 13th St.
East Moline, IL 61244
(309) 765-8000

Case International Farm Equipment
Company Distribution Service (CDS)
P.O. Box 09359
Milwaukee, WI 53209-0359
(414) 636-7699

Ford - New Holland Publications
P.O. Box 1000
Ronks, PA 17572
(800) 635-4413 or (717) 355-3317

INFORMATION SHEET #2

Using the Parts Catalog

Generally, a parts catalog is compiled for each piece of machinery. The purpose of the catalog is to provide exploded views of various parts of the machine. The related parts that make up the assembly are also shown.

The parts are usually indexed in the front or back of the catalog. Their descriptions may be indexed alphabetically and/or their part numbers may be indexed numerically.

For example, if a customer knows that he or she needs a steering column sleeve for a particular tractor, but doesn't know the part number, the customer would look in the first few pages of the tractor parts catalog for the alphabetical index to find "steering" and the page number on which it appears as shown below:

Grid	Alphabetical Listing	Page
2A25	STEERING VALVE ASSEMBLY	57-6
2B1	STEERING VALVE ASSEMBLY	57-7
2B14	STEERING VALVE ASSEMBLY	57-20
2A23	STEERING VALVE CYLINDER	57-4
2A24	STEERING VALVE CYLINDER COVER	57-5
2B2	STEERING VALVE CYLINDER COVER	57-8
2A23	STEERING VALVE PISTON	57-4
2A21	STEERING WHEEL	57-2
2A22	STEERING WHEEL	57-3
2B10	STEERING WHEEL	57-16
2B12	STEERING WHEEL	57-18
2A21	STEERING WHEEL EMBLEM	57-2
2A22	STEERING WHEEL EMBLEM	57-3
2B10	STEERING WHEEL EMBLEM	57-16
2B12	STEERING WHEEL EMBLEM	57-18
2A22	STEERING, FIXED	57-3
2B12	STEERING, FIXED	57-18
2A21	STEERING, TELESCOPING	57-2
2B10	STEERING, TELESCOPING	57-16
2G1	STEP, TRACTOR	80-8
2G2	STEP, TRACTOR	80-9
2G3	STEP, TRACTOR	80-10
1129	STROKE CONTROL VALVE, HYDRAULIC PUMP	55-4
2F7	SUPPORT, CONTROL	75-12
2D22	SUPPORT, DRAWBAR FRONT	60-8
2F16	SUPPORT, HYDRAULIC CONTROL LEVERS	75-21
1119	SUPPORT, HYDRAULIC PUMP DRIVE	55-1
2D23	SWAY CONTROL BLOCKS	60-9
2F12	SWITCH, DIMMER	75-17
2F12	SWITCH, KEY	75-17
2F12	SWITCH, LIGHT	75-17
2G20	SWITCH, SOLENOID	85-4
2G22	SWITCH, SOLENOID	85-6
2G25	SWITCH, SOLENOID	85-9
2H1	SWITCH, SOLENOID	85-10
1F5	SWITCH, START-SAFETY	40-10
1G9	SWITCH, START-SAFETY	40-12
2F12	SWITCH, STARTER	75-17
2G23	SWITCH, STARTER SOLENOID	85-7

On the other hand, if the customer knows that the part number is R 51153 and that it came from a specific tractor, but doesn't know the name of the particular part, the customer would look in the numerical index for "R 51153" as shown below:

Numerical Index

	Part No.	Grid	Key	Page
R	51058	1G4	22	41-7
R	51060	1G4	11	41-7
R	51061	1G4	7	41-7
R	51062	1G4	12	41-7
R	51063	1G4	10	41-7
R	51067	1G15	23	41-19
R	51073	1C12	10	25-2
R	51079	2A22	24	57-3
R	51080	2A22	25	57-3
R	51080	2B12	8	57-18
R	51109	2G1	2	80-8
R	51109	2G1	2	80-8
R	51109	2G2	2	80-9
R	51109	2G3	5	80-10
R	51119	2E24	24	75-4
R	51119	2B7	21	57-13
R	51120	2B9	29	57-15
R	51120	2B17	13	57-24
R	51127	2112	1	90-16
R	51130	2C16	3	59-8
R	51132	2E7	5	65-1
R	51153	2A21	26	57-2
R	51153	2B11	27	57-17
R	51159	1F2	14	40-7
R	51160	2D5	29	59-22

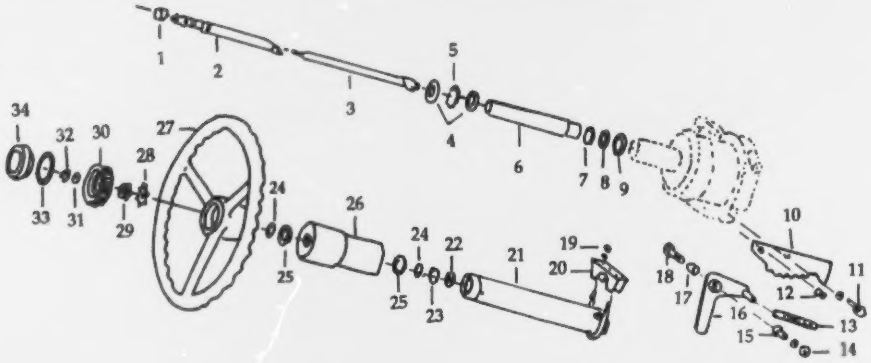
To verify that you are ordering the correct part, it should match the exploded view and "Key" number. The key numbers are the consecutive part identification numbers found on the exploded view. For example, the part having a key number of 26 on the exploded view is part number R 51153 with the description of "sleeve, steering column." These key numbers are used in the exploded view rather than part numbers because of the lack of space.

The "Grid" refers to the microfiche copy of the parts catalog. Many companies now use the microfiche parts catalog rather than the paper copy for several reasons. They are less bulky and easy to organize in a rather small space, as well as inexpensive to produce and easy to update.

Microfiche

Most farm equipment manufacturers will supply microfiche copies of their catalogs to dealerships. Microfiche is an individual photograph of a reduced document mounted on a card; the order of photographs, therefore, can be changed, unlike that of microfilm. The information on a microfiche card includes parts identification numbers, availability, bin locations, and price. The microfiche copies of manufacturers catalogs are kept in trays the size of shoeboxes. The manufacturer supplies a dealer with a microfiche catalog, but also updates the information on a regular basis. The dealer can then update catalog information by pulling the old card from the tray and replacing it with the new one.

TELESCOPING STEERING
(TRACTOR SERIAL NO. -027634)



KEY		PART NO.	TRACTOR SERIAL NO.	DESCRIPTION
1	R	50875	(-)	BUSHING
2	R	50868	(-)	SHAFT, STEERING
3	AR	50408	(-)	ROD, STEERING COLUMN RELEASE
4	JD	9931	(-)	RACE, THRUST (2 USED)
5	JD	8875	(-)	BEARING, NEEDLE
6	AR	55289	(-)	COUPLING, STEERING SHAFT, W/ADAPTER
7	R	54048	(-)	RING, RETAINING
8	R	54058	(-)	WASHER
9	R	54063	(-)	SEAL, OIL
10	R	51816	(-)	PLATE, STEERING VALVE TILT LOCK
11	19H	2552	(-)	SCREW, CAP, 3/8" x 1-1/8"
	12H	304	(-)	WASHER, LOCK, 3/8"
12	R	43663	(-)	SCREW, SPECIAL CAP
13	M	2036T	(-)	SPRING
14	14H	812	(-)	NUT, 3/8"
	12H	304	(-)	WASHER, LOCK, 3/8"
15	R	51815	(-)	SPACER
16	AR	56104	(-)	LEVER, ADJUSTING
17	R	28035	(-)	BUSHING
18	19H	3181	(-)	SCREW, CAP, 3/8" x 2"
19	14H	650	(-)	NUT, 5/16" (2 USED)
	12H	303	(-)	WASHER, LOCK, 5/16" (2 USED)
20	R	56251	(-)	SADDLE (SUB. FOR R53606)
21	AR	76538	(-)	TUBE, STEERING COLUMN, WITH BUSHING (SUB. FOR AR56060)
22	R	32730	(-)	SEAL, OIL
23	R	26933	(-)	RING, SNAP
24	B	169R	(-)	RING, SNAP (2 USED)
25	R	42629	(-)	WASHER (2 USED)
26	R	51153	(-)	SLEEVE, STEERING COLUMN
27	T	22875	(-)	WHEEL, STEERING
28	T	17148	(-)	WASHER, SPECIAL
29	14H	904	(-)	NUT, JAM, 3/4"
30	R	50871	(-)	KNOB, RELEASE
31	R	40716	(-)	WASHER, SPECIAL
32	R	11151	(-)	NUT, SPECIAL JAM
33	R	3690R	(-)	O-RING
34	R	47998	(-)	EMBLEM, STEERING WHEEL

INFORMATION SHEET #3

Using the Price List

Each manufacturer of machinery and equipment will have a different system of numbering parts. Most part numbers have three distinct divisions: the prefix, the body, and the suffix. An example of a part number is D4LS 3400 M.

The *prefix* consists of a series of letters and/or numbers which appears before the principal section (body) of the part number. In the example above, D4LS is the prefix.

The *body* contains the principal figures of the part number. In the example above, the body is 3400. When listing part numbers in numerical order, it is the body that determines the order.

The *suffix* consists of a series of letters and/or numbers which appears after the principal section (body) of the part number. In the example above, M is the suffix.

Some part numbers may have letters in the body of the number, such as D5LS 3A564 Q. Although 3A564 is the body of the number, only the number 3564 is used to determine its numerical order. As a general rule, the part numbers appear in numerical order with the smallest number first. However, some catalogs vary by listing first those part numbers with no letter prefixes; followed by part numbers with letter prefixes, the prefixes listed alphabetically by letter and then numerically by number.

List Price and Net Price

Besides the part number in the price list, you will generally find a column with the heading "suggested list" or "list price." This is the retail selling price recommended by the manufacturer.

The "net price" is generally the dealer's cost of the part. In practice, the net price is usually estimated by subtracting a percentage of the list price. In some cases, a net price may be indicated by a code number in the price list. This is sometimes listed as a reference number.

The letters or blanks contained in the reference number indicate the location which is a source of supply for the parts listed. The first two digits represent the cents and the remaining digits reading from left to right, represent the dollars. For example, reference number 421B is $1.42 and reference number 062D02 is $202.06. A "C" indicates the price per hundred units. For example, reference number 415B with list price $6.30C is $6.30/100 list price and $5.41/100 net price.

Care must be exercised when looking up prices. Two very similar parts may be listed next to each other in the parts list. One part may be worth $1.50 while the other, only one line different, may be valued at $1250.00. Looking on the wrong line could cause a serious billing error.

INFORMATION SHEET #4

Keeping Accurate Labor Records

Dealers generally sell labor or service time to customers in one of two ways:

1. Rate per hour — an actual accounting of the labor that was required to complete the customer's repair job.

2. Flat rate — a predetermined amount of labor based upon each type of repair job.

It is important that an accurate record be kept of daily shop time. Most machinery dealers have a time card and clock that is used by the employee to "punch in" and "punch out" for each job. Some time cards are placed on the back of the shop tickets while others are kept separate.

The time card information is used for the following:

1. So dealers can make the proper charges to the customer in order to recover the costs of operating their service shop.

2. So employees are properly paid for their time.

3. So customers are fairly charged for the service work that has been done on their equipment.

Time Tickets

Worker's Time Ticket and Record

Customer's Name ①				Off 8
Job No. ②	Operation	Reg.	Ov't	
Date ③	⑤	⑥	⑦	⑧
Emp. No. ④				On
Customer's Name *Brown*				Off 7
Job No. *204*	Operation	Reg.	Ov't	10:18
Date *8/5*	*Hydraulics*	✓		8:09
Emp. No. *6*				On
Customer's Name *Jones*				Off 6
Job No. *201*	Operation	Reg.	Ov't	11:05
Date *8/5*	*Electrical*	✓		10:25
Emp. No. *6*				On
Customer's Name *Baker*				Off 5
Job No. *208*	Operation	Reg.	Ov't	11:55
Date *8/5*	*Steam Clean*	✓		11:10
Emp. No. *6*				On
Customer's Name *Baker*				Off 4
Job No. *208*	Operation	Reg.	Ov't	2:11
Date *8/5*	*Remove Cab*	✓		1:05
Emp. No. *6*				On
Customer's Name *Roth*				Off 3
Job No. *207*	Operation	Reg.	Ov't	4:36
Date *8/5*	*Rebuild Clutch*	✓		2:18
Emp. No. *6*				On
Customer's Name				Off 2
Job No.	Operation	Reg.	Ov't	
Date				
Emp. No.				On
Customer's Name				Off 1
Job No.	Operation	Reg.	Ov't	
Date				
Emp. No.				On

		Regular	Overtime
Customer Work ⑨			
Company	Trade & Repossessions		
⑩	Assembly and Handling		
Work	All other		
Supervision ⑪			
Come Back ⑫			
Shop & Unassigned ⑬			
⑭ Total @ ⑮ Per Hour			
Total @ %			
Total			
Service Foreman ⑯	Mechanic ⑰	No. ⑱	

1. Customer's name — This identifies the customer to be charged.
2. Job No. — This number is assigned by the shop foreman.
3. Date — Generally, one card is used each day.
4. Employee No. — This is a permanent number assigned to each employee by the shop foreman.
5. Operation — This identifies the kind of repair work (e.g. starter, radiator, air-conditioning, etc.)
6. Regular hours — The normal work day may be 8 hours and the work week may be 40 hours.
7. Overtime hours — Work hours exceeding 8 hours per day are listed here.
8. Off/On — The time clock figures appear here. There are places for eight different jobs during the day.
9. Customer work — This indicates the time that was spent on customer service.
10. Company work — This indicates the time that was spent reconditioning used equipment received in trade, assembling and servicing company owned machinery and equipment.
11. Supervision — This indicates time that was spent supervising other workers.
12. Come Back — This indicates time that was spent on machinery that was returned due to improper repair during primary service.
13. Shop and unassigned — Miscellaneous shopwork unrelated to assigned jobs is described here.
14. Total — The total of all hours worked on this time ticket is listed here.
15. Per hour — This indicates the wage rate in dollars per hour paid to this employee.
16. Service foreman — Initials of the foreman in approval of this time ticket are inserted here.
17. Mechanic — Initials of the worker turning in this time ticket are inserted here.
18. No. — This is the same as employee n[illegible] item 4 above.

INFORMATION SHEET #5

The Shop Service Charge

The following labor cost factors must be covered in charges for shop services:

1. Salary of shop foreman or manager.
2. Salaries of shop and service employees other than mechanics.
3. Dealer's share of social security.

In some dealerships, one or more of the following may have to be covered in charges for shop service:

1. Paid coffee breaks.
2. Paid lunch hours.
3. Paid vacation time.
4. Paid sick time.
5. Paid hospital insurance.
6. Paid retirement funds.
7. Paid holidays.
8. Paid life insurance.
9. Paid profit-sharing plans.

The following shop expenses must also be covered by charges for shop activities:

1. Electricity.
2. Taxes.
3. Insurance.
4. Tools.
5. Shop supplies.

Dealers must establish a charge rate for their service shop labor. They must be careful to establish a price that is not above market but which is high enough to enable the service shop to make a fair profit. Service charges from $28.00 to $32.00 per hour are not uncommon. This amount is more than the hourly rate of the mechanic. The shop labor costs and shop expenses must be figured into the rate charged to the customer and still leave some profit.

The average labor pay rate for the mechanic working in a shop is $7.55 per hour. The average customer charge for shop service is $27.00 per hour.

Charges are generally not made to the minute, but more likely to the nearest tenth or quarter of an hour. When calculating to the nearest quarter of an hour, for every 7 minutes or less, drop back to the nearest quarter hour. For time that is 8 minutes or more, add the next quarter hour.

INFORMATION SHEET #6

The Flat Rate Charging Method

Some dealers would rather charge for service labor by the job rather than by the hour. This means that a certain fixed charge is established for each job that the shop normally performs. There is a predetermined charge for the labor for each job, such as:

1. Grinding valves.
2. Adjusting the brakes.
3. Rebuilding the clutch.
4. Overhauling an engine.
5. Setting up a machine.

Advantages of flat rate charging:

1. Each customer pays the same price for the same job performed on the same type of equipment.
2. It is easier to charge fairly on jobs that must be interrupted to do other things.
3. Faster shop service may be accomplished. A mechanic whose pay is tied to jobs completed rather than to clock hours is apt to work faster and waste less time.
4. An established price for repairs aids in making trade-in allowances on used equipment.
5. Estimating the cost of repair jobs is quick and easy. The customer knows what the job will cost in advance.

Disadvantages of flat rate charging:

1. There is always the possibility of running into unexpected complications on a particular job.
2. There may be a tendency for a mechanic to hurry through a job in order to get to the next one.
3. It may be difficult to establish proper prices for some jobs.
4. Slow workers upset the flat-rate schedule.

If all goes well on the job, some work may be finished in less time than was allotted by the flat rate schedule. If difficulties arise, the job may take longer. The easy jobs and the difficult jobs generally average out and flat rate can be charged.

This does not mean that "time records" are any less important. The dealer must check the time spent on each job in order to determine the average time spent on various jobs. Each dealer should make up a flat rate chart for each job in the shop. These are generally established on the hours estimated to complete the job multiplied by the hourly rates generally used for shop service by this company. Flat rate schedules need to be modified when it is determined that established times are not average or when pay rates and other labor costs change.

INFORMATION SHEET #7

Calculating Flat Rate Charges

The following are some examples of flat rate charges. Figure the labor charges at $27.00 per hour.

Engine Tuning (Diesel)

Minor	4.0 hours	$108.00
Complete	8.4 hours	$226.80

Engine Overhaul

Minor: overhaul sleeves, pistons, rings, main and rod bearings; tune engine; overhaul oil pump, carburetor, and ignition unit or injection nozzles, and turbo-charger; clean and wash engine	39.3 hours	$1,061.10

Cooling System

Replace water pump (cold)	1.5 hours	$40.50
Replace water pump (hot) with loader	2.5 hours	$67.50

Electrical and Ignition

Remove starter, install new brushes, resurface commutator bearings, test and adjust	2.1 hours	$56.70

Engine Clutch

Overhaul clutch, including bearings, cover assembly; reline or renew plate and release levers	6.2 hours	$167.40

Brakes

Replace shoes, both sides and adjust brakes	0.3 hours	$8.10

Diesel Tune-Up

Remove and reinstall one nozzle and check spray pattern	0.4 hours	$10.80
Remove and reinstall injection pump	1.6 hours	$43.20

Final Drive and Axle

Overhaul final drives, both sides and differential unit	13.5 hours	$364.50

Tractor Clean and Paint

Clean and paint tractor assembly	13.0 hours	$351.00

Sheet Metal

Remove and reinstall one fender	1.8 hours	$48.60
Remove and install hood	0.6 hours	$16.20
Remove and install cab	5.4 hours	$145.80

INFORMATION SHEET #8

The Shop Repair Order

The shop order is:

1. An authorization for mechanics to do the work. No work should be done unless it is listed on this form. The shop repair order is initiated by the service manager when the customer brings in the equipment. This is a written understanding between the customer and the company as to what work should be done on the equipment.
2. A written list of parts used. No parts should be issued for a repair job unless the shop ticket is presented to the parts department and each item recorded.
3. A record of all labor performed in the repair of equipment. Labor may be directly recorded on the shop ticket or attached later when time tickets have been turned in to the company office.
4. A permanent file copy of service work done on a particular piece of equipment. This may be of later use if the machine comes back as a trade-in.
5. A management tool by which the shop operations may be improved; a record of the productivity of individual workers as well as the shop as a whole.

The shop order (ticket), is recorded on a form with several copies. This shop ticket:

1. Gives the name and address of the customer.
2. Identifies the equipment that needs work.
3. Indicates the jobs to be completed on this equipment (filled in by the service manager).
4. Lists the parts that are used for repairs (completed by the parts department).
5. Is used by the bookkeeper to make proper payment to the workers (when time is recorded directly onto the shop ticket).
6. Is used by the bookkeeper to make proper charges to the customer.
7. Is given to the customer as a record of the repair work.

The shop ticket is generally in triplicate (three copies). One of these is the customer's invoice copy, the second is an office file copy, and the third is usually a light cardboard copy which can take rough handling in the shop without being destroyed. On the reverse side of this shop copy there may be a place to record all labor performed on a particular piece of equipment. This may be used with a time clock or may have time entries made by hand.

Shop Repair Order

Cust Acct No. ①	Cust Order No. ②	
Name	Order Written by:	
Address ③	Received	
Phone	Promised ④	
Type of Machine	Hourmeter or Mileage	Phone
Make ⑤	Serial No.	
Model	Motor No.	

Qty	Part Number	Description	Unit Price	Amount
	⑧			

Brought Forward

Work Done by:	Total Parts

Outside work ⑩

By:	Total Outside Work

National Farm & Power Equipment Dealers Association

Work to Be Done

Labor Only
Material Additional

Lubricate ☐ Change Oil ☐ Flush Trans. ☐ Flush Diff ☐ Clean ☐ Paint ☐

Job Index	Operation Number	Amount	Job Index	Operation Number	Amount
☐ Brakes	⑥		Brought Forward		
☐ Carburetor			☐ Governor		
☐ Clutch			☐ Hydraulics		
☐ Cooling			☐ Ignition		
☐ Diesel Sys.			☐ Rings/Pins		
☐ Dyna Check			☐ Rods/Mains		
☐ Eng. Inspec.			☐ Starting		
☐ Eng. Overhaul			☐ Steering		
☐ Eng. Tune			☐ Trans.		
☐ Generator			☐ Valves & Tappets		
SUBTOTAL			☐ Wheels & Bearings		

⑦

Mileage __________ @ __________

Other Materials		Total Service	
Gals. Fuel @		Total Parts	
Qts. Oil @	⑫	Total Outside Work	
Lbs. Grease @		Total Other Materials	
		Dynamometer	
		Pickup & Delivery	⑪
		Subtotal	
Total		Sales Tax (Where Applicable)	⑬
		Grand Total	⑭

I hereby authorize the repair work to be done as described above on the machine(s) named hereon. All repair parts are to be billed at your regular prices. I agree to pay cash for such repair parts and labor on delivery of machine(s) or on terms satisfactory to you and until paid in full any unpaid balance shall constitute a lien on this machinery. I further agree that you will not be held responsible for loss or damage to said machinery from fire, theft or other causes beyond your control. ⑯

Date __________ Signed __________ ⑮

⑰ I 51221

Dynamometer Chart on Reverse Side ⑨

The Repair Order

1. Customer account number — If the business extends credit, this number is necessary for billing purposes.

2. Customer order number — Often a customer is incorporated or is in a partnership and may require purchase orders to have work done. If this is the case, the purchase order number is written on this line, although the tickets are generally filed by the number in the lower right-hand corner.

3. Name, address, and phone number — It is important that the customer's name and address be listed correctly to aid in proper billing. The telephone number may be important if it is necessary to call the customer while work is being done on his or her equipment.

4. Order written by, received, promised — The shop order is usually written by the service manager. The date received is a record of when the shop took possession of the machine to begin repairs. Date promised helps in scheduling work in the shop and customers like to know when their work will be finished.

5. Identification — Type of machine, hourmeter, or mileage reading, make, serial number, model and motor number provide positive identification of the machine being worked on. These will also be used to obtain the correct parts for the machine.

6. Work to be done — This section is a quick checklist of work to be done on the equipment. The operation number may refer to a flat rate schedule. The amount may refer to hours of labor allocated to each job.

7. Detail section — Detailed instructions to the mechanic may be written here by the service manager. The total for this section appears in the lower right-hand corner.

   NOTE: The above sections, 1 through 7, are usually completed by the service manager.

8. Parts record — The quantity, part number, description, and price are listed in this section. The mechanic or parts department must be sure that all parts are listed. The total for this section also appears in the lower right-hand corner. In the lower left-hand corner is a space for a mechanic's initials as verification that the parts listed have been installed.

9. Dynamometer — This is a test done to measure horsepower. This test is often performed after engine work has been done to see if the machine is operating at its rated horsepower. A dynamometer chart sometimes appears on the back of the shop ticket.

Dynamometer Chart		
Test	Before Repair	After Repair
Cylinder	1 2 3 4	1 2 3 4
Compression	5 6 7 8	5 6 7 8
Vacuum	Inches	Inches
Gas Consumption	Gals/Hr.	Gals./Hr.
PTO Speed	RPM	RPM
PTO Horsepower	HP	HP

10. Outside work — There are some jobs that the service shop may not be equipped to do, such as injection pump rebuilding. The customer is generally charged only what it will cost the company. This total is transferred to the lower right-hand column.

11. Pickup and delivery — There is an additional charge for any pickup or delivery that the shop must make.

12. Other materials — This area lists "prices" of bulk materials used in the service operation for each customer such as rags, grease, saw blades, drill bits and miscellaneous small parts such as nuts, bolts, cotter keys, etc. While it has been traditional in many dealerships to simple write off the cost of small incidental parts and fittings as part of the service cost of doing business, there is a growing concern that the cumulative total of these incidental parts represents a significant leak in service profitability. The trend is towards pricing out all parts required on a repair job by making a flat charge to cover the cost of such incidentals. Typically, this charge is 5 percent of labor, not to exceed a predetermined maximum of 20 hours.

13. Sales tax (where applicable) — The law requires that the seller collect the appropriate sales tax and have the customer certify any items that are exempt from the tax.

    Exemption certifications must be executed by the purchaser. The certificate must include the seller's name and address, the purchaser's name and address, and a statement that the property purchased will be used primarily in production agriculture. Retailers may accept blanket certificates as a part of their books and records. Retailers are required to exercise good faith in accepting exemption certificates. If, however, a retailer reasonably believes that the purchaser will use farm machinery or equipment in production agriculture and accepts the certificate in good faith and the purchaser does not, in fact, use the machinery or equipment in production agriculture, the purchaser will be liable to the Department for the tax. An item of farm machinery and equipment which is initially used primarily in production agriculture and, having been so used for less than one-half of its useful life, is converted to primarily nonexempt uses, will become subject to tax at the time of the conversion. Such tax will be collected on such portion of the price of the machinery and equipment as was excluded from tax at the time the sale or purchase was made.

    Despite exemptions from state sales tax, municipalities may reimpose local taxes on farm machinery and equipment by ordinance, the RTA by reimposition. The Metro-East, County Supplementary and Water Commission Taxes may not be imposed.

    Notwithstanding the fact that the sales tax may be at retail, the Retailer's Occupation Tax does not apply to sales of machinery and equipment under certain exempt conditions, including purchase of machinery and equipment (1) to be used in production agriculture, (2) to be leased for use in production agriculture, and (3) to be used in custom farming and special service operations.

    The following is a list of definitions of production agriculture and its subdivisions.

    a. Production agriculture is the raising or propagation of livestock or crops for sale for human consumption; crops for livestock consumption; the production of seed stock grown for the propagation of feed grains and the husbandry of animals or for the purpose of providing a food product, including the husbandry of blood stock as a main source of providing a food product. Production agriculture also includes animal husbandry, floriculture, horticulture and viticulture.

    b. Horticulture is the business of producing vegetables, vegetable plants, and nursery stock, including the operation of nurseries and orchards, but not the sale of plants by retail outlets which do not grow the plant stock.

    c. Floriculture is the business of producing flowers, Christmas trees or other decorative trees, plants, shrubs, sod, including such operations as greenhouses.

    d. Viticulture is the business of growing grapes or operating vineyards.

    e. Production agriculture, with respect to crops, is limited to activities necessary in tilling the soil, planting, irrigating, cultivating, applying herbicide, insecticide or fertilizer, harvesting and drying of crops. Specialized food production operations which produce plants under controlled environments in growing media other than soil, qualify as production agriculture. Activities such as the clearing of land, mowing of fence rows, creation of ponds or drainage facilities are not included, nor are the operations involved in the storing or transporting of crops or produce. The processing of crops into food or other products is not production agriculture. With respect to the raising of or propagation of livestock and husbandry of animals, the animals must be domestic farm animals raised for a profit. The raising of wild animals, game birds, and house pets would not be considered to be production agriculture.

    f. The transport, slaughter, and processing of animals or animal food products are not considered to be production agriculture.

    The following is a list of descriptions of machinery and equipment which may and may not be exempted from sales tax when used in production agriculture.

    a. The exemption applies only to items of farm machinery and equipment, either new or used, certified by the purchaser to be used primarily for production agriculture, and including machinery and equipment purchased for lease. Excluded from this exemption are motor vehicles required to be registered pursuant to the Illinois Motor Vehicle Code. Registered vehicles other than motor vehicles may qualify for the exemption if they are used primarily in production agriculture rather than in transportation or other nonexempt activities. The law exempts only the purchase and use of farm machinery and equipment used in production agriculture. Accordingly, no other type or kind of tangible personal property will qualify for the exemption.

b. Machinery means major mechanical machines or major components thereof contributing to the production process. Farm machinery would include tractors, combines, balers, irrigation equipment, cattle and poultry feeders, but not improvements to real estate such as fences, barns, roads, grain bins, silos, and confinement buildings. Certain machines qualify for the exemption if purchased by farmers directly from retailers, even though they are installed as realty improvements. Such machines include but are not limited to augers, grain dryers (heaters and fans), automated livestock feeder bunks (but not ordinary building materials), automatic stock waterers (powered by electricity or water pressure and built into a permanent plumbing system), and water pumps serving production areas, specialty heating or lighting equipment specifically required by the production process (e.g., ultraviolet lights and special heaters for incubation). General heating, lighting, and ventilation equipment does not qualify as farm machinery or equipment. A person (such as a plumbing contractor) who contracts to provide and install an exempt machine or equipment permanently into real estate must obtain an Exemption Certificate from the person purchasing the machine. The contractor must furnish certification to the seller, attaching the certificate of the purchaser in order to claim the exemption.

c. A tractor or other machinery which qualifies for the exemption may include options or accessories which are not farm equipment. However, these items must be installed and sold both as an integral part of the qualifying machine and in a single transaction.

d. Equipment means any independent device or apparatus separate from any machinery, but essential to production agriculture. A farm wagon assembled at the time of sale from components selected by the purchaser such as a bed, running gear or wheels which are sold as a unit, will be treated as a single item of farm equipment. Equipment used in farm management such as radios and office equipment, in repair and servicing of equipment, and in security and fire protection is not farm equipment. *Nor does the exemption apply to equipment used in farm maintenance, administration, selling, marketing, or the exhibition of products. The exemption does not include hand tools and wholly hand-operated equipment such as wheelbarrows, hoes, rakes, pitchforks, shovels, brooms, wrenches, pliers, and grease guns.*

e. New or used *repair* or replacement parts, necessary for the operation of the machine used in production agriculture, qualify for the exemption. However, accessories or replacements not essential to the operation of the machinery itself, except when sold as an integral part of a qualified machine at the time of purchase, such as radios and tool or utility boxes, do not qualify for the exemption. *Included in the repair or replacement parts categories are batteries, tires, fan belts, mufflers, spark plugs, plow points, standard-type motors and cutting parts. Consumable supplies such as grease, oil and anti-freeze, and twine and wire are not repair or replacement parts.*

Exemptions from sales tax are made for machinery and equipment purchased for lease, to be used by the lessee primarily in production agriculture qualifies for the exemption. The lessor purchasing such equipment must certify that the equipment will be used primarily in production agriculture. Should a purchaser-lessor subsequently lease the machinery or equipment primarily to lessees who do not use it in a manner that would qualify for the exemption, the purchaser-lessor will become liable for the tax that was previously exempted.

Finally, exemptions from sales tax are made for machinery and equipment purchased by custom farmers or operators of special services such as crop dusting, fertilizer spraying, and combining or corn shelling, who provide a service-for-hire on farms other than their own which is an integral part of production agriculture may also claim the exemption if the equipment is used primarily in production agriculture.

Exemption: Machinery and equipment used or leased for use primarily in production agriculture.

Definition of Production Agriculture

Includes These Activites

- Tilling
- Planting
- Irrigating
- Cultivating
- Applying Chemicals
- Applying Fertilizers
- Harvesting
- Drying
- Raising of or Propagation of Livestock

Does Not Include These Activities

- Clearing Land
- Mowing Fence Rows
- Creating Ponds or Drainage Facilities
- Storage of Crops
- Food Processing
- Slaughtering

Exempt machinery, equipment, and related repair parts:

If Used in Production Agriculture

These Items are Exempt

- Augers
- Balers
- Batteries
- Cattle Feeders
- Combines
- Cutting Parts
- Fan Belts
- Farrowing Crates
- Flooring (if used in waste disposal)
- Gestation Stalls
- Grain Dryers (Heaters and Fans)
- Heating (Specialty)
- Hoes
- Irrigation Equipment
- Lighting (Specialty)
- Livestock Feeder Bunks (Automated)
- Motors
- Mufflers
- Pitchforks
- Plow Points
- Portable Panels (for confinement facilities)
- Poultry Cages
- Poultry Feeders
- Rakes
- Shovels
- Spark Plugs
- Stock Waterers (Automatic)
- Tires
- Tractors
- Vehicles, Nonmotorized (Nonlicensed)
- Vehicles, Motorized (Nonlicensed)
- Water Pumps (if serving production areas)
- Wheelbarrows

These Items Are Not Exempt

- Anti-Freeze
- Baling Twine
- Baling Wire
- Barns
- Boots
- Building Materials (affixed to real estate)
- Chemicals (used in waste disposal system)
- Confinement Buildings
- Fences
- Filters, Air and Oil
- Fire Protection
- Fuel
- Grain Bins
- Grease
- Grease Guns
- Hammers
- Heating (General)
- Lighting (General)
- Office Equipment
- Oil
- Overshoes
- Pliers
- Radios
- Roads
- Screwdrivers
- Security Systems
- Silos
- Tool Boxes
- Utility Boxes
- Vehicles, Motorized (licensed)
- Ventilation (General)
- Wire Stretchers
- Work Gloves
- Wrenches

Other: Custom farmers or special service operators who provide a service for hire, on farms, which is an integral part of production agriculture may also claim this exemption.

Certification: A customer *must* provide a written certification that the item being purchased will be used "primarily" in production agriculture. This certification may cover one purchase or multiple purchases (blanket exemption).

Sample Blanket Certificate

Name ______________________ Address ______________________

Special Blanket Certificate of Exemption for Farm Supply Dealers

The undersigned hereby claims exemption on purchase of tangible personal property from ______________________ on or after ______________________
Name of Vendor Date

and certifies that this claim is based upon the purchaser's proposed use of the items purchased, the activity of the purchaser, or both, as shown hereon:

( ) 1. Sold to another vendor for resale.
( ) 2c. Directly in production of personal property for sale by farming.
( ) 6b. Packages, materials, or equipment used in production of personal property for sale by farming.
( ) 8a. Equipment or materials used directly in production of articles used in the production of other personal property for sale by farming.
( ) 8b. Equipment or materials used in holding or conditioning of materials for sale by farming.
( ) 8c. Materials or parts to be incorporated into articles to be used in production of personal property for sale by farming.
( ) **Other —** specify by number from back of card or Rule TX-11-03

This certificate shall continue in force until revoked and shall be considered a part of each order given to the above named vendor unless the order specifies otherwise.

Vendors License NO., if any ______________________
Date Signed ______________________
Farm & Power Equip. Retailer of Ohio

Purchaser
Name ______________________
Address ______________________
By ______________________
Activity ______________________
Ohio Grain, Feed & Fertilizer Assoc., Worthington

The appropriate reason, from the following list shall be inserted in the unit or blanket exemption certificate when claiming exemption or exception from the Ohio Sales or Use Taxes.

1. For resale in the form in which the same is, or is to be, received.

2. For use or consumption:
   a. As a material or part for incorporation into personal property to be produced for sale by manufacturing, assembling, processing or refining.
   b. Directly in production of personal property for sale by manufacturing, processing, refining, assembling or mining.
   c. Directly in production of personal property for sale by farming, agriculture, horticulture or floriculture.

5. A sale:
   a. To a church.
   b. To an organization not-for-profit, operated exclusively for charitable purposes in this state.

6. A sale, of packages or of materials and parts therefore, or of machinery, equipment, and materials for use in packaging personal property for sale or sold at retail, to a person engaged in
   a. Production of personal property for sale by farming, agriculture, horticulture or floriculture.

7. A sale, to a person engaged in manufacturing, assembling, processing or refining, of handling and transportation equipment, other than motor vehicles licensed to operate on public highways, for use in:
   a. Intra plant transfers of personal property in the process of production for sale.
   b. Shipment, between plants operated by the same person, of personal property in the process of production for sale.

8. A sale, to a person engaged in farming, agriculture, horticulture or floriculture of tangible personal property for use or consumption:
   a. Directly in the production of articles for use or consumption directly in the production of other personal property for sale.
   b. In conditioning or holding of products produced for sale, or in conditioning or holding of articles produced for use or consumption directly in the production of other personal property for sale.
   c. As a material or part for incorporation into articles to be produced for use or consumption directly in production of other personal property for sale.

Refer to Rule TX 11-03 for additional information on the following: 2. d. Oil and Natural Gas, e. Public Utilities, f. Making retail sales, g. Industrial cleaning, h. Towel and linen Service, i. Commercial fishing. 3. Security. 4. Insurance. 5. c. Ships. 6. a. Manufacturing, c. Crude Oil and Gas, d. Making retail sales. 9. Medical and surgical devices. 10. Emergency and fire equipment. 11. Air pollution facilities. 12. Water pollution. 13. Out of state retailer purchasing in Ohio.

14. Grand total — This total is obtained by adding the totals from each section.

15. Customer signature — The customer signature acknowledges and authorizes the work to be done on the equipment. It also indicates the customer's agreement to pay for this service. Without it, you have no legal assurance of collecting for the work you do and the parts you provide. If the customer is a company or business, the name of the company and the name and title of the individual authorizing the work should be included in the customer authorization area. If additional work is required after the customer has authorized the original repair, the additional work should be described and initialed by the customer.

16. Consumer protection clause — If the job to be done involves extensive repair, an estimate should be given approximating the projected cost of the service job, and permission from the customer should be obtained for any expenditures above the original estimate. This will help protect the dealer from dissatisfied customers and potential law suits.

17. Ticket number — Each shop ticket can be identified by the number assigned to it. Using consecutively numbered repair orders safeguards against employees using the system for personal gain. Repair orders must be audited on a regular schedule and all numbers, including voids, accounted for.

Shop Repair Order

Qty	Part Number	Description	Unit Price	Amount	
1	17956 BK	Fan Belt	6.21	6	21
1	69721 BT	Alternator Belt	6.90	6	90
1	13562 BJ	Air. Cond. Belt	6.65	6	65
1	913 656 R2	Gasket Set	150.00	150	00
6	26581	Rod Bearings	13.40	80	40
6	986 372 R11	Main Bearings	17.32	103	92
1	911 652 R6	Rear Thrust Bearing	39.20	39	20
12	932 498 N	Valve Springs	2.90	34	80
1	919 432 R8	Sleeve & Piston Set	1150.00	1150	00
6	4291 PL 6	Injectors (Trade)	17.50	105	00
1	952 391 R2	Breather-Element	4.26	4	26
2	989 765 R2	Fuel Filters	8.75	17	50
1	492 30116	Oil Filter	2.96	2	96
1	64996	Bearing	10.18	10	18
1	10069 421	Throwout Bearing	18.76	18	76
1	942 68 CP	Clutch Plate	96.73	96	73
Brought Forward					

Work Done by: Mike Mechanic	Total Parts	1833	47

Outside work

Rebuild Injection Pump	493	00
Wrist pin Bushings Honed & Installed	36	00
Plane Head	20	00
By: Total Outside Work	549	00

Cust Acct No.	Cust Order No. 235	
Name Bruce Farmer		Order Written by:
Address Anytown		Received 2/15/89
Phone		Promised 2/20/89
Type of Machine Tractor	Hourmeter or Mileage 14,125	Phone 123-4567
Make CFT	Serial No. 8910 111213	
Model 180	Motor No. 141516	

Work to Be Done

Labor Only
Material Additional

Lubricate ☐ Change Oil ☒ Flush Trans. ☐ Flush Diff ☐ Clean ☐ Paint ☐

Job Index	Operation Number	Amount	Job Index	Operation Number	Amount
☐ Brakes			Brought Forward		
☐ Carburetor			☐ Govenor		
☐ Clutch			☐ Hydraulics		
☐ Cooling			☐ Ignition		
☒ Diesel Sys.			☐ Rings/Pins		
☒ Dyna Check			☐ Rods/Mains		
☐ Eng. Inspec.			☐ Starting		
☒ Eng. Overhaul			☐ Steering		
☒ Eng. Tune			☐ Trans.		
☐ Generator			☐ Valves & Tappets		
SUBTOTAL			☐ Wheels & Bearings		

Overhaul engine and clutch tune-up

49 hrs. labor @ $27.50 1347 50

Mileage ________ @ ________

Other Materials			Total Service	1347 50
Gals. Fuel @			Total Parts	1833 47
8 Qts. Oil @ $1.05	8	40	Total Outside Work	549 00
Lbs. Grease @			Total Other Materials	35 90
Misc.			Dynamometer	
@ 5% to 20 hrs	27	50	Pickup & Delivery	30 00
			Subtotal	
Total	35	90	Sales Tax @ 6.5% (Where Applicable)	119 18
			Grand Total	3915 05

I hereby authorize the repair work to be done as described above on the machine(s) named hereon. All repair parts are to be billed at your regular prices. I agree to pay cash for such repair parts and labor on delivery of machine(s) or on terms satisfactory to you and until paid in full any unpaid balance shall constitute a lien on this machinery. I further agree that you will not be held responsible for loss or damage to said machinery from fire, theft or other causes beyond your control.

Date 2/15/89 Signed Bruce Farmer

No 08500

National Farm & Power Equipment Dealers Association

Dynamometer Chart on Reverse Side

INFORMATION SHEET #9

Handling Customer Complaints

Turning problems into opportunities

Whenever a salesperson helps a customer feel that the company is looking out for its customer's best interests, customer loyalty to the company and its products is sure to improve. This does not imply that all situations can be easily resolved. Occasionally, a given customer may be unable or unwilling to recognize that a judgment against his or her wishes can still be fair. When customer and company part as friends, both have much to gain, and the service manager is assured of having turned a sticky problem into a golden opportunity.

When dealing with customer complaints, keep in mind that the customer may not be expressing facts, but intense feelings. The service manager who is prepared to listen empathetically to a seemingly endless tirade of complaints may find that when the customer finally runs out of steam, so do the negative feelings.

People sometimes bottle up real or imagined wrongs. Feelings become so intense that they must have a release. Creating an outlet for their feelings can often alleviate much of the problem. If you can listen without sitting in judgement or becoming irate yourself, you may find that the problem will be made easier to deal with when the storm has blown over.

The value of questions

Customers with complaints are sometimes half-convinced they will not get a fair hearing before you can even talk to them. Probing, to-the-point questions alleviate this fear. By ferreting out valuable factual information that might lead to another diagnosis of the problem, the customer is moved from an emotional, accusatory state to a logical, exploratory one.

Saving face

On occasion, when the problem is not serious and involves little or no economic harm, the service manager may even want to accept part of the responsibility for the "confusion." Perhaps he or she should have explained some facet of the product more completely, or maybe the instructions were not clear enough.

Even if the service manager is convinced that the instructions were clear enough for anyone to follow, he may find that the payoff for such face-saving suggestions is the customer's gratitude and an even more comfortable business relationship in the future. However, be extremely careful in accepting blame for product failures when it is not warranted. You will likely end up making matters worse as the customer will expect restitution that you may not be able to give.

Head off complaints before they happen

Many machines and services are highly technical and the customers must be well informed and educated on how to use the product and what to expect. A large number of complaints can be traced back to customers' misunderstanding or misuse of products. Then, either to save face or because they legitimately don't know they erred, they blame the product, the company, and ultimately the service manager.

These situations are often the most difficult to handle because the customer is in error and no restitution can or should be given. This occurrence calls for the greatest tact and skills a service manager can muster. Often the customer cannot be convinced and will "get even" by dropping you as a supplier of equipment and services and/or telling everyone of his or her dissatisfaction.

Don't oversell the product or service. All discontent is relative to expectation. If the product or service is better than the customer expects, you'll be a hero. If it's less than expected, you'll be a villain. Make sure, through careful presentation, that your customer's expectations are reasonable.

Handling customer complaints

1. Complaints may be viewed as opportunities because, if handled in a tactful, correct way, they may allow the service manger/technician to increase his or her credibility with customers.
2. Preparation is an important component of handling a complaint. Have good background information on the person issuing the complaint. Knowledge about company restitution policies prevents the promising of unreliable compensation.
3. Maintain a calm, tactful appearance and react with interest and respect to a customer's charges.
4. Many complaints can be prevented before they ever arise by carefully monitoring, if possible, the customer's use of the product.

5. Be empathetic. Listen carefully to the customer's complaints and try to put yourself in his or her situation.

6. Be certain that you understand the problem as the customer has stated it. Repeat the essence of the complaint to show the customer that you have understood it.

Customer complaint — case problem

It took some years of doing, but Sam Farmer has finally established his farm as a growing, profitable operation. Now in his early fifties, Sam has more time to think about refinements, future planning, and the like. Part of that planning has been involved with keeping existing equipment in top running order and adding new units in line with increasing planted acreage.

He is particularly proud of the tractor he bought over a year ago because only the farmers who are "really making it" own them.

The problem is that Sam's tractor (now out of warranty) developed some serious mechanical problems. Originally the machine was to have been repaired by Wednesday, now it is Friday. To make matters worse, Sam was told his repair bill would be from $850.00 to $1000.00. Sam was just handed a bill for $998.00 and it really made him hot under the collar.

How would you handle Sams questions and remarks?

1. But you told me the repairs would cost $850.00! Now you expect me to pay one hundred and fifty dollars more!

2. What good is an estimate anyway, if you don't stick by it?

3. Welland Implement could have done a complete overhaul job for that kind of money.

4. Joe Newton had the same problem with his tractor and you fixed it for less than $800.00.

5. It looks to me like you've used secondhand replacement parts, too. You're really out to clip a guy, aren't you?

6. You'd think for the kind of money you people make on selling a tractor like mine you'd bend a little when it comes to repairs.

7. It seems to me like you only build these machines to barely outlast the warranty.

8. Are you suggesting I caused the problems to start with?

9. I guess you must think I'm stupid.

10. I've been farming for 25 years and I know how to run a tractor.

11. I was talking to your serviceman, the redheaded fella that worked on my tractor. I don't think he knows one end of a tractor from the other.

12. How come you didn't have Larry work on it? He's the only guy in your service department that really knows what he's doing.

13. I guess my business just isn't important to you people anymore.

14. Well, actions speak louder than words to me.

15. The bill you just gave me is bad enough, but here it is Friday, you promised I'd be back in the field by Wednesday.

16. Do you realize how much it's costing me everyday I'm not in the field?

17. Who pays for my crop losses if I don't get them all out?

18. When a person spends the kind of money I have for a tractor, he shouldn't have as much trouble as I've had with this one, should he?

19. That doesn't make any sense to me.

20. How do you know I haven't got a lemon?

21. I was thinking of purchasing another tractor from you people, but if this is the kind of service I can expect . . . .

22. Is this the way you treat friends and customers?

23. I wonder if your competition treats customers like this?

24. Can you promise me I won't have anymore problems with this tractor?

25. Does the owner know how you people handle service problems, and the way you overcharge?

26. I'd like to talk to the owner myself and get this whole thing straightened out.

27. I think you really know I'm right, but you're afraid to admit it, aren't you?

28. Maybe I ought to write a letter to the company president. Maybe that'll get some action.

INFORMATION SHEET #10

Pre-Delivery and Delivery Service

Every piece of equipment going out of the service shop should be inspected and approved by the shop foreman for both workmanship and appearance.

The appearance of the machine should make the customer proud to own it. This should be true whether it is the customer's repaired machine, a newly set-up unit, or a piece of reconditioned equipment.

Pre-delivery inspection will help to assure the dealer of satisfied customers.

Some tips that will help to further build customer good will are:

1. When a new machine is delivered, the farmer should get an operator's manual and be briefed on the operation and care of the unit.
2. The service shop should start new equipment and make a trial run to see that everything is in working order.
3. There should be a follow-up by a service worker or salesperson in 30 to 60 days after the delivery of new equipment to see if everything is operating properly.
4. Someone from the shop should take time to talk with the customers about the repair work that has been done on their equipment. This may save a recurrence of the breakdown at a later date. It may also reassure the customers that they received their money's worth for the repair job.
5. Information from company service bulletins should be passed on to the customers when this will help them in the maintenance and operation of their machines

Delivery Service and Operation Communication

Whenever a piece of equipment is sold to a customer it is important that operation and service information be communicated to him or her by the delivery person. A thorough knowledge of the equipment is required to be able to properly explain and demonstrate this information to the customer. Also, this communication process needs to be clear and concise and presented with a degree of empathy on the part of the delivery person. Not only does the information need to be correct, it needs to be understood by the customer. This can be accomplished by careful questioning and close observation on the part of the delivery person.

An example list of items that need to be explained and demonstrated when delivering a tractor are presented on the following pages.

Delivery Service

Explain and Demonstrate:

- ☐ 1. Operator's Manual — Delivery and review
- ☐ 2. Safety — Review safety rules
- ☐ 3. Hardware — Give customer Operator's Manual and explain warranty; complete and sign delivery service form in Operator's Manual
- ☐ 4. Seat Adjustments
- ☐ 5. Starting and Stopping
- ☐ 6. Braking System and Parking Brake
- ☐ 7. Instruments and Controls
  - a. Transmission sentry tellite
  - b. Data center
  - c. Fuse box
  - d. Throttle, A/C, heater, etc.
- ☐ 8. Transmission Controls
  - a. Range Pattern
  - b. Speed Pattern
  - c. Park Lock and Interlock
- ☐ 9. Torque
  - a. Wheel Bolts
- ☐ 10. Towing Instructions
- ☐ 11. Hydraulic Controls
- ☐ 12. Hitch Controls and Operations
- ☐ 13. Hood Panel Latches
- ☐ 14. IPTO — Control and Operation
- ☐ 15. Venting Diesel Fuel System
- ☐ 16. Prime the Turbo-charger — If tractor has not been operated for 30 days
- ☐ 17. Lubrication Chart — Fluid charge intervals
  - a. Diesel Engine — 200 hrs (see Operator's Manual)
  - b. Chassis
  - c. Transmission, Power Train, and Hydraulic System — 12 mos or 1000 hrs, whichever occurs first
- ☐ 18. Cooling System Maintenance
  - a. Air box
  - b. Radiator and Heat Exchanger
- ☐ 19. Filters — Explain replacement and intervals
  - a. Engine Air — Only when needed or 1 year service
  - b. Engine Oil — Replace every 200 hrs
  - c. Fuel — When needed
  - d. Hydraulic — Change after 10 hrs, 100 hrs, 200 hrs, and every 200 hrs thereafter; clean screen in reservoir - 200 hrs
  - e. Coolant — Change after 100 hrs and every 400 hrs thereafter
  - f. A/C — as required
- ☐ 20. Fuel — Diesel No. 2
- ☐ 21. Break-In Procedure

100 Hour After-Delivery Service

☐ 1. Check Adjustments

- a. Clutch
- b. Brakes
- c. Shift linkage
- d. Belts
- e. Park lock

☐ 2. Instruments and Gauges — Check operation

☐ 3. Check Engine RPM

- a. Low idle — 800 ± 25 RPM
- b. High Idle — 2655 ± 35 RPM

☐ 4. Radiator — Check for trash on the radiator

☐ 5. Road Test — Check for unusual noises and proper function of all controls

☐ 6. Hoses — Check the air cleaner and radiator hoses for tightness

☐ 7. Explain — Draining of the "ship away" oil (see Operator's Manual)

☐ 8. Filters — Be sure that the filter change periods are thoroughly understood

- a. Hydraulic 10 - 100 - 200 hrs and every 200 hrs thereafter
- b. Engine — 200 hrs (see Operator's Manual)
- c. Water — 100 hrs and every 400 hrs thereafter

☐ 9. Correct — Any discrepancy

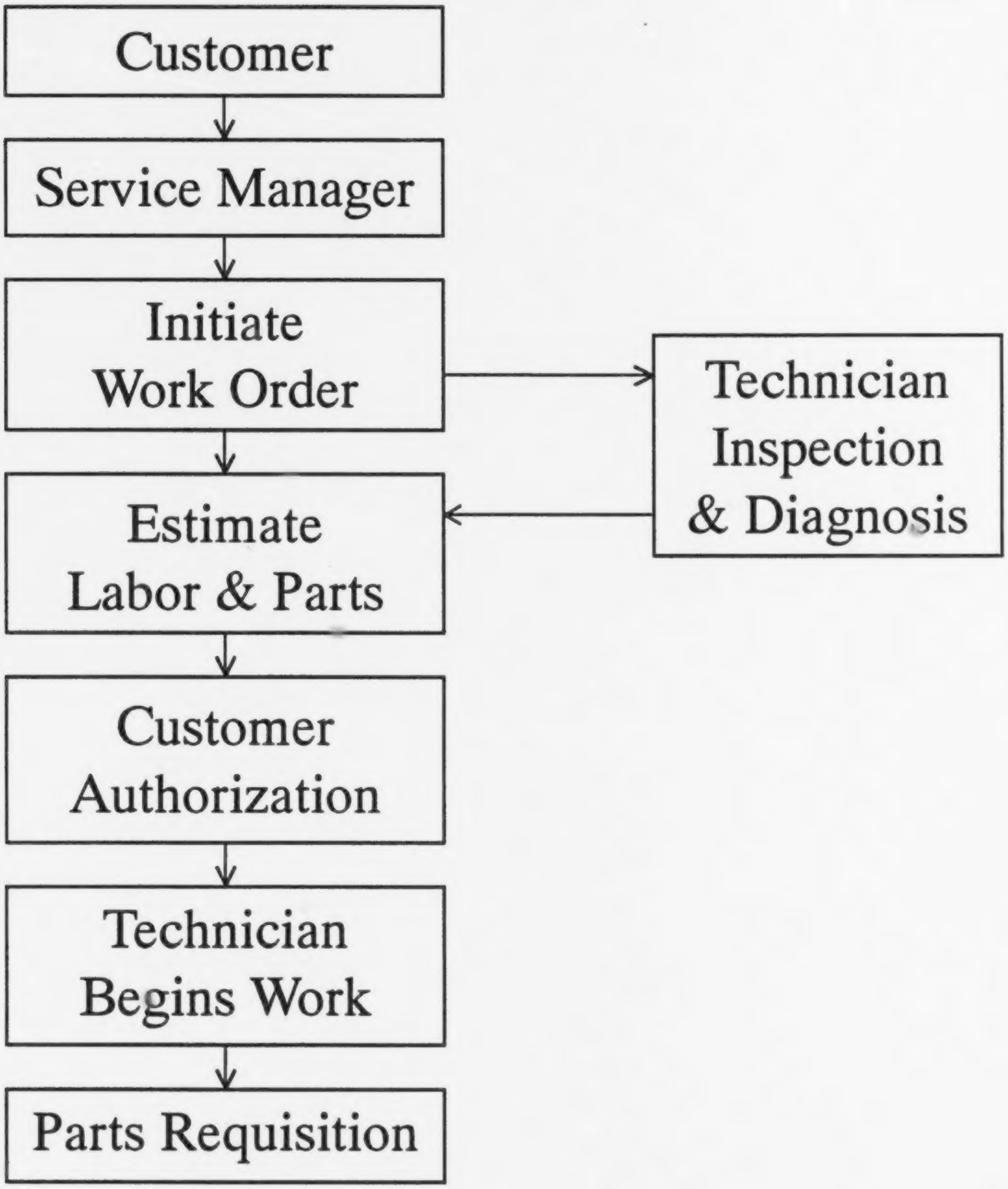
☐ 10. Record — Owners comments for future reference

☐ 11. Review — The warranty

TRANSPARENCY MASTER #1

Work Order Flow Chart

(Write-up Phase)



Customer

Service Manager

Initiate Work Order

Technician Inspection & Diagnosis

Estimate Labor & Parts

Customer Authorization

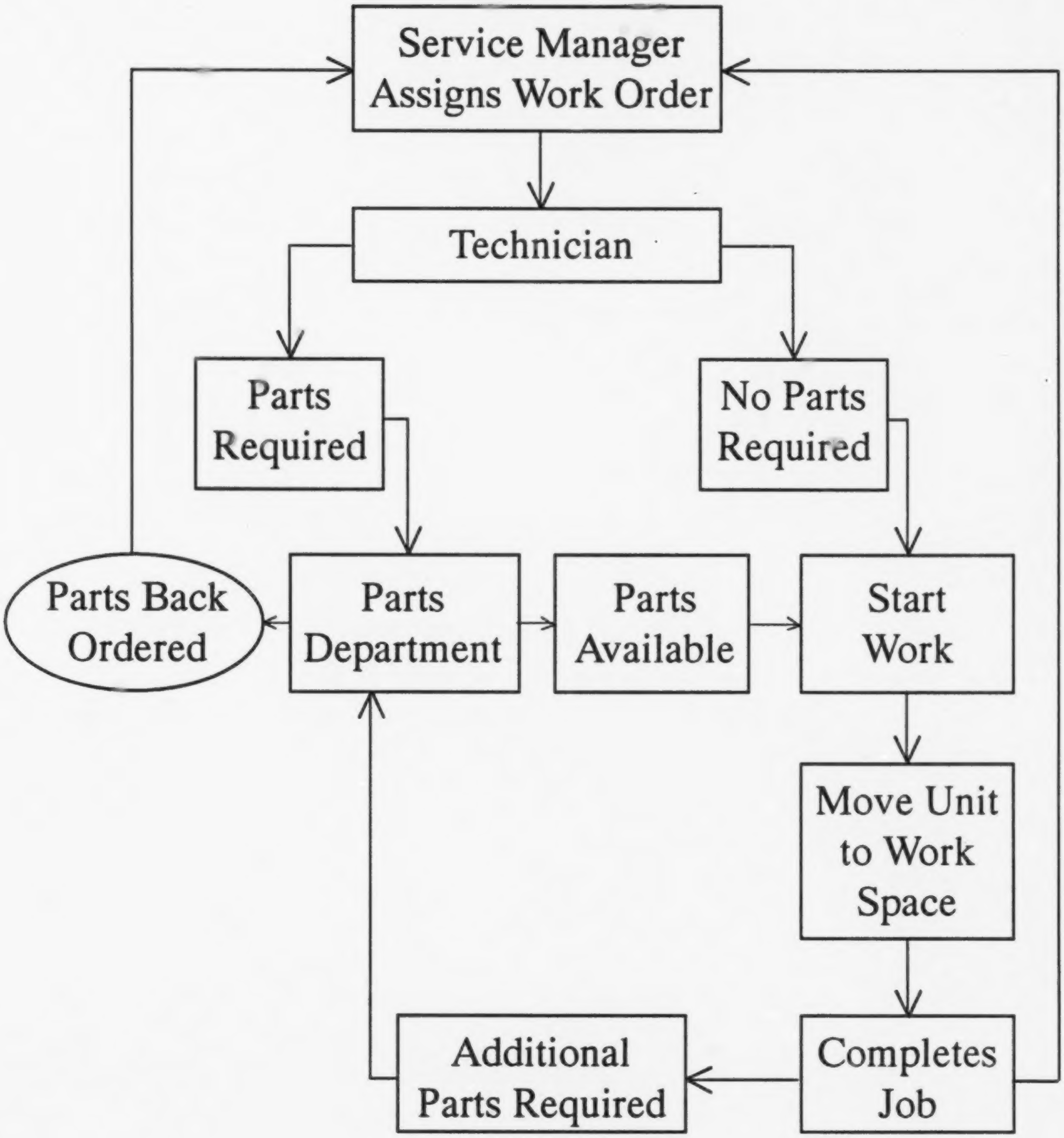
Technician Begins Work

Parts Requisition

TRANSPARENCY MASTER #2

Work Order Flow Chart

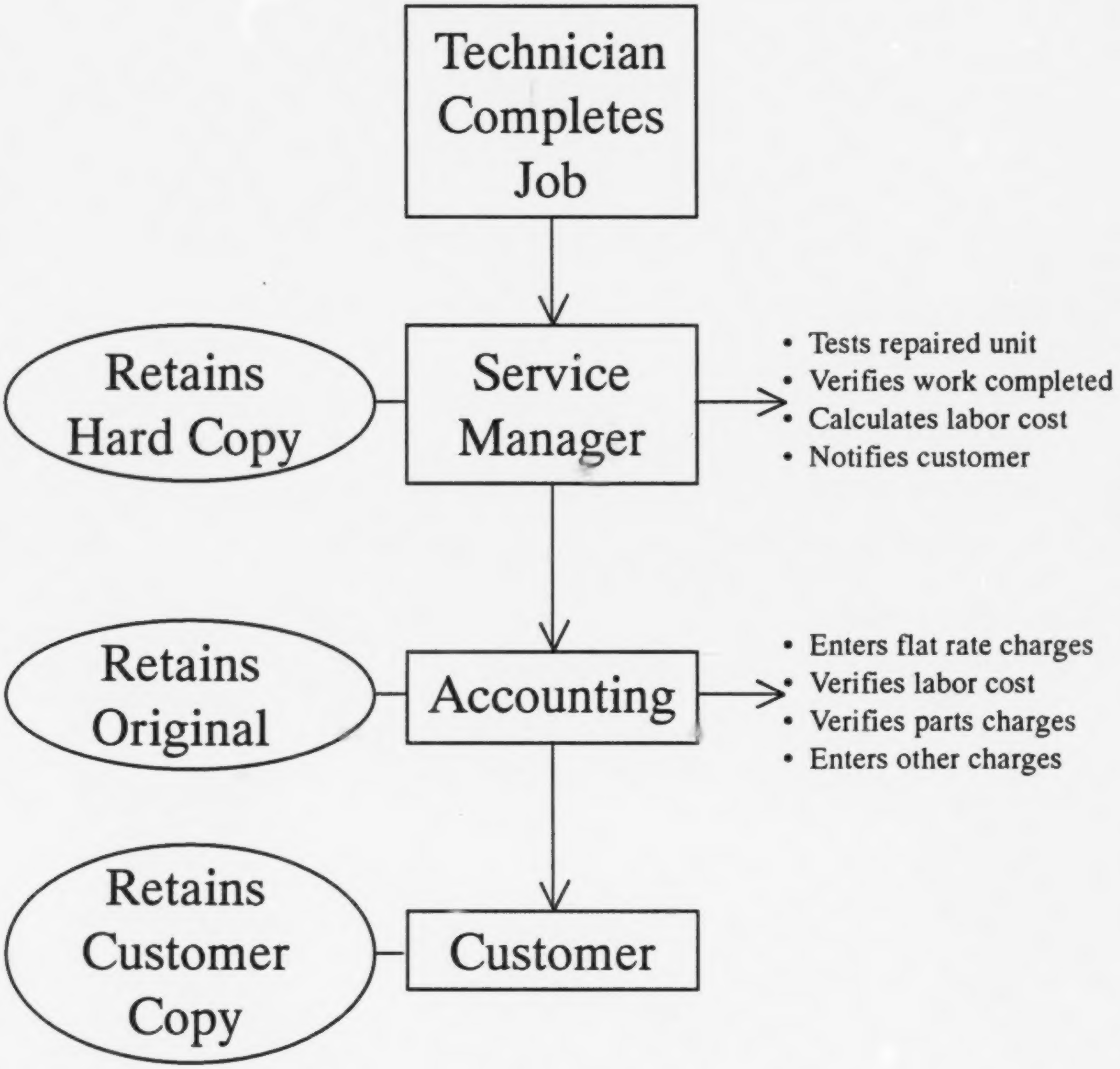
(Work Period Phase)


Service Manager Assigns Work Order
Technician
Parts Required
No Parts Required
Parts Back Ordered
Parts Department
Parts Available
Start Work
Move Unit to Work Space
Additional Parts Required
Completes Job

TRANSPARENCY MASTER #3

Work Order Flow Chart

(Billing and Accounting Phase)



Technician Completes Job

Retains Hard Copy — Service Manager

- Tests repaired unit
- Verifies work completed
- Calculates labor cost
- Notifies customer

Retains Original — Accounting

- Enters flat rate charges
- Verifies labor cost
- Verifies parts charges
- Enters other charges

Retains Customer Copy — Customer

TRANSPARENCY MASTER #4

Shop Repair Order

Qty	Part Number	Description	Unit Price	Amount

Brought Forward

Work Done by: Total Parts

Outside work

By: Total Outside Work

National Farm & Power Equipment Dealers Association

Cust Acct No.	Cust Order No.
Name	Order Written by:
Address	Received
Phone	Promised

Type of Machine	Hourmeter or Mileage	Phone

Make	Serial No.
Model	Motor No.

Work to Be Done Labor Only Material Additional

Lubricate ☐ Change Oil ☐ Flush Trans. ☐ Flush Diff ☐ Clean ☐ Paint ☐

Job Index	Operation Number	Amount	Job Index	Operation Number	Amount
☐ Brakes			Brought Forward		
☐ Carburetor			☐ Govenor		
☐ Clutch			☐ Hydraulics		
☐ Cooling			☐ Ignition		
☐ Diesel Sys.			☐ Rings/Pins		
☐ Dyna Check			☐ Rods/Mains		
☐ Eng. Inspec.			☐ Starting		
☐ Eng. Overhaul			☐ Steering		
☐ Eng. Tune			☐ Trans.		
☐ Generator			☐ Valves & Tappets		
SUBTOTAL			☐ Wheels & Bearings		

Mileage ________ @ ________

Other Materials		Total Service	
Gals. Fuel @		Total Parts	
Qts. Oil @		Total Outside Work	
Lbs. Grease @		Total Other Materials	
		Dynamometer	
		Pickup & Delivery	
		Subtotal	
Total		Sales Tax (Where Applicable)	
		Grand Total	

I hereby authorize the repair work to be done as described above on the machine(s) named hereon. All repair parts are to be billed at your regular prices. I agree to pay cash for such repair parts and labor on delivery of machine(s) or on terms satisfactory to you and until paid in full any unpaid balance shall constitute a lien on this machinery. I further agree that you will not be held responsible for loss or damage to said machinery from fire, theft or other causes beyond your control.

Date ____________ Signed ______________

I 51221

Dynamometer Chart on Reverse Side

STUDENT ACTIVITIES

STUDENT WORKSHEET #1 — Calculating Labor From a Time Card

STUDENT WORKSHEET #2 — Understanding Parts Numbers

For additional activities, teachers may refer to the "Suggested Teaching Activities and Procedures" section in the Instructor's Guide.

1597

STUDENT WORKSHEET #1

Calculating Labor From a Time Card

When using military time, calculate time to the nearest hundredth of an hour. When using minutes, calculate time to the nearest minute. When figuring charges, round to the nearest quarter hour or tenth of an hour, whichever is appropriate.

Clock Time			$ / Hour Shop Rate	Charges to Nearest Qtr or Tenth Hour
Stop: 9.80				
Start: 8.10	____ hrs		$27.00	________
Stop: 13.60				
Start: 12.80	____ hrs		$32.50	________
Stop: 17.29				
Start: 14.54	____ hrs		$25.75	________
Stop: 11.40				
Start: 6.90	____ hrs		$31.25	________
Stop: 17.25				
Start: 13.15	____ hrs		$34.50	________
Stop: 11.50				
Start: 9.40	____ hrs	____ min	$29.75	________
Stop: 10.18				
Start: 7.35	____ hrs	____ min	$30.25	________
Stop: 4.14				
Start: 12.35	____ hrs	____ min	$26.75	________
Stop: 3.06				
Start: 2.43	____ hrs	____ min	$29.50	________
Stop: 11.48				
Start: 9.03	____ hrs	____ min	$32.75	________

STUDENT WORKSHEET #1 — Key

Calculating Labor From a Time Card

When using military time, calculate time to the nearest hundredth of an hour. When using minutes, calculate time to the nearest minute. When figuring charges, round minutes to the nearest quarter hour and military time to a tenth of an hour.

Clock Time				$ / Hour Shop Rate	Charges to Nearest Qtr or Tenth Hour
Stop:	9.80				
Start:	8.10	1.70 hrs		$27.00	$45.90
Stop:	13.60				
Start:	12.80	0.80 hrs		$32.50	$26.00
Stop:	17.29				
Start:	14.54	2.75 hrs		$25.75	$70.81
Stop:	11.40				
Start:	6.90	4.50 hrs		$31.25	$140.63
Stop:	17.25				
Start:	13.15	4.10 hrs		$34.50	$141.45
Stop:	11:50				
Start:	9:40	2 hrs	10 min	$29.75	$66.94
Stop:	10:18				
Start:	7:35	2 hrs	43 min	$30.25	$83.19
Stop:	4:14				
Start:	12:35	3 hrs	39 min	$26.75	$100.31
Stop:	3:06				
Start:	2:43	0 hrs	23 min	$29.50	$14.75
Stop:	11:48				
Start:	9:03	2 hrs	45 min	$32.75	$90.06

STUDENT WORKSHEET #2

Understanding Parts Numbers

Arrange the following in the order in which they should appear in the price catalog:

__________ A6VP 1C345 B

__________ 224106

__________ A1HR 1243 A

__________ 12A 0Z23 49

__________ 126798

__________ B1NN 0149 H

__________ B1NO 1A241 P

__________ 119346

__________ D2PF 6C521 A

STUDENT WORKSHEET #2 — Key

Understanding Parts Numbers

Arrange the following in the order in which they should appear in the price catalog:

5	A6VP 1C345 B	1345
9	224106	224106
4	A1HR 1243 A	1243
1	12A 0Z23 49	023
8	126798	126798
2	B1NN 0149 H	0149
3	B1NO 1A241 P	1241
7	119346	119346
6	D2PF 6C521 A	6521

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agricultural Engineering/Mechanization

PROBLEM AREA: Understanding and Maintaining Small Engines

RELATED PROBLEM AREAS:

1. Repairing and Maintaining Agricultural Equipment
2. Manufacturing, Distributing, Selling, and Servicing Agricultural Equipment
3. Repairing and Maintaining Small Engines (Horticulture Cluster)

PREREQUISITE PROBLEM AREA(S):

1. Identifying Basic Principles of Agricultural Mechanics (Central Core Cluster)

LEVEL: Preparatory

OCCUPATIONAL TASKS ADDRESSED:

Agricultural Business and Management Cluster

Duty I: Assembling, Servicing, and Maintaining Equipment and Facilities

1. Maintain hand tools
2. Perform maintenance checks on equipment
3. Change cartridge air filters
4. Lubricate equipment
5. Replace bearings
6. Troubleshoot equipment failure
7. Prepare equipment for off-season storage
8. Service fuel systems
9. Service electrical systems
10. Service lubrication systems
11. Test engine compression

Duty R: Applying Safety Practices

1. Comply with shop and equipment safety rules
2. Inspect work area and equipment for safe working environment

Horticulture Cluster

Duty L: Servicing and Maintaining Equipment and Facilities

1. Service small four-cycle and two-cycle engines
2. Maintain hand tools
3. Lubricate and adjust power equipment
4. Troubleshoot equipment failure
5. Order equipment parts
6. Perform routine maintenance and repairs

7. Prepare equipment for off-season storage
8. Assemble mowers for display
9. Assemble snowblowers for display
10. Demonstrate use of mowers
11. Demonstrate use of snowblowers

Duty R: Applying Safety Practices

1. Comply with safety requirements for working around automated equipment

STATE GOALS FOR LEARNING

In planning the instruction for this problem area, teachers can promote the development of several student learning objectives which are related to the State Goals for Learning in Biological and Physical Sciences, Mathematics, and the Social Sciences. These objectives are listed on the Learning Assessment Plan forms included on the following page(s). Those learning objectives marked with an asterisk (*) are taken from the sample lists provided by the Illinois State Board of Education.

CORE

Illinois Agricultural Core Curriculum

Agricultural Education 124 Mumford Hall 1301 W. Gregory Drive University of Illinois Urbana, IL 61801

Director: Dale A. Law, Ed.D.
Principal Investigator: Jerry D. Pepple, Ed.D.
Research Assistant: Robert E. Petrea

Illinois Agricultural Core Curriculum Rev.

Agricultural Business and Management
Agricultural Engineering/Mechanization

Submission Date ____________
☐ Original submission ☐ Revision
Page ____ of ____

I. LEARNING AREA *(check one)*
☐ Language Arts
☒ Mathematics
☐ Sciences
☐ Fine Arts
☐ Social Sciences
☐ Physical Development/Health

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)
COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐
District Name
City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able make and use measurements, including those of area and volume.

Contact Person: ____________
Title: ____________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	V. EXPECTATIONS Percent of Students Expected to Achieve Objective
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:					
*1. Measure in a variety of contexts using appropriate units.					
*2. Convert from one unit to another when given a conversion rule.					
3. Identify small engine tools and measuring devices and demonstrate their proper use.					
1604					1605

ISBE 41-76 (1/88)

Understanding and Maintaining Small Engines

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date________________
☐ Original submission ☐ Revision
Page ____ of ____

(Affix label or complete district information.)
COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐
District Name
City

I. LEARNING AREA *(check one)*

☐ Language Arts
☐ Mathematics
☒ Sciences
☐ Fine Arts
☐ Social Sciences
☐ Physical Development/Health

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will have a working knowledge of the principles of scientific research and their applications in simple research.

Contact Person: ________________
Title: ________________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	V. EXPECTATIONS Percent of Students Expected to Achieve Objective
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:					
*1. Solve equations and inequalities found in everyday life.					
2. Identify small engine tools and measuring devices and demonstrate their proper use.					
1606					1607

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

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Submission Date ______
☐ Original submission ☐ Revision
Page ____ of ____

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☒ Sciences ☐ Physical Development/Health

(Affix label or complete district information.)
COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐
District Name
City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will have a working knowledge of the processes, techniques, methods, equipment, and available technology of science.

Contact Person: ______
Title: ______
Phone: ( )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Apply quantitative observational methods to accumulate precise data.					
*2. Analyze the results of an experiment.					
3. Identify and describe specific science principles integral to the operation of a small internal combustion engine.					
1608					1609

ISBE 91-78 (1/88)

Submission Date ____________

☐ Original submission ☐ Revision

Page ____ of ____

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)

COUNTY	DISTRICT	ESC

District Name

City

I. LEARNING AREA *(check one)*

- ☐ Language Arts
- ☐ Mathematics
- ☒ Sciences
- ☐ Fine Arts
- ☐ Social Sciences
- ☐ Physical Development/Health

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will have a working knowledge of the concepts and basic vocabulary of biological, physical, and environmental sciences and their application in contemporary technological society.

Contact Person: ____________

Title: ____________

Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Understand the principle and implications of friction.					
*2. Understand the effect of various factors on the rate of reaction.					
*3. Relate the resulting movement of an object to the forces applied.					
4. Identify and describe specific science principles integral to the operation of a small internal combustion engine.					
5. Name the parts of a small engine and explain the function of each.					
1610					
					1611

ISBE 41-78 (1/86)

Illinois Agricultural Core Curriculum Rev.

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date________
☐ Original submission ☐ Revision
Page ____ of ____

(Affix label or complete district information.)

COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐

District Name

City

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☐ Mathematics ☒ Social Sciences
☐ Sciences ☐ Physical Development/Health

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to apply the skills and knowledge gained in the social sciences to decision making in life situations.

Contact Person: ____________
Title: ____________
Phone: ( )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Understand the knowledge and skills required for success in selected fields of work.					
*2. Recognize that competence in a field of work entails the development of a wide range of skills.					
5. Disassemble, repair, and reassemble a small engine to the specifications of the manufacturer's manual.					
1612					1613

ISBE 41-78 (1/88)

Agricultural Business and Management
Agricultural Engineering/Mechanization

Understanding and Maintaining Small Engines

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agricultural Engineering/Mechanization

PROBLEM AREA: Understanding and Maintaining Small Engines

STUDENT LEARNING OBJECTIVES

Upon completion of their study of this problem area, students will be able to:

1. Define terms integral to understanding and maintaining small engines.
2. Define and explain the events that take place during each stroke of a four-cycle and a two-cycle engine.
3. Name the parts of a small engine and explain the function of each.
4. Identify small engine tools and measuring devices and demonstrate their proper use.
5. Disassemble, repair, and reassemble a small engine to the specifications of the maintenance manual.
6. Identify and describe specific science principles integral to the operation of a small internal combustion engine.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agricultural Engineering/Mechanization

PROBLEM AREA: Understanding and Maintaining Small Engines

PROBLEMS AND QUESTIONS FOR STUDY

1. How does a small engine operate?
2. What are the differences between a four-stroke and two-stroke engine?
3. What are the advantages and disadvantages of four-stroke and two-stroke engines?
4. What are the parts of a small engine?
5. How do the parts of a four-stroke engine differ from those of a two-stroke engine?
6. What is the function of each part of a small engine?
7. What tools are used in the repair and maintenance of a small engine?
8. How are the tools properly used?
9. What are the steps in disassembling a small engine?
10. How are repairs to a small engine made?
11. What are the steps in reassembling a small engine?
12. What procedures will be followed in working on a small engine?
13. What type of service must be performed on a regular basis to keep a small engine functioning properly?
14. Who are the major manufacturers of small engines?
15. Why are science principles important to the operation of a small engine?

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agricultural Engineering/Mechanization

PROBLEM AREA: Understanding and Maintaining Small Engines

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES

1. Use local retail businesses, repair shops, and manufacturer's representatives as resources for additional information on small engines.

2. Conduct a field trip to a local retail business or repair shop to observe the disassembly, repair, and reassembly of small engines.

3. Distribute Student Worksheet #1. In completing this worksheet students should refer to VAS Unit *Small Engines —Principles of Operation, Troubleshooting & Tune up.*

4. Distribute Student Worksheet #2. In completing this worksheet students should refer to VAS Unit *The Two-Cycle Engine.* The teacher should discuss or the students should study the material in that Unit concerning similarities and differences between two- and four-cycle engines.

5. Distribute Student Worksheet #3. In completing this worksheet students should refer to VAS Transparency Set *Small Gas Engines.* The teacher should discuss or the students should study the material in that Transparency Set concerning small engine parts and carburetion systems of small engines.

6. Conduct a demonstration of small engine tools to provide the information necessary for students to complete Student Worksheet #4. Allow for student practice in using small engine tools. After sufficient practice have students complete Student Worksheet #6.

7. Use Student Worksheets #11 - #14 as examples of specific science principles involved in small engine operation.

8. Consult problem area *Identifying Basic Agricultural Mechanics Principles* for a discussion on mechanical power transmission. Lead the class in a discussion on application of this principle to small engine uses.

9. Use Student Worksheet #7 as an introduction to the specifications of small engines. Use VAS Transparency Set *Small Gas Engines* as a resource.

10. Use Student Worksheets #8 and #9 as guides for students to obtain information needed in overhauling either a four-stroke or a two-stroke engine.

11. Use VAS Filmstrips *Ignition Systems* and *Exhaust, Lubrication, Cooling and Tools* as visual aids to enhance student understanding of relevant concepts.

12. Use Student Worksheet #10 as a guide for students to use in preparing engines for storage.

13. Consult Information Sheet #1 for a list of manufacturer's addresses and additional materials available for use with this problem area.

14. Have students write a letter to a manufacturing company requesting information on new products available from that company.

15. Have students conduct a survey of the local retail area and make a list of the small engines available. An additional activity could be to collect advertisements and pamphlets available from the various companies.

16. Have students complete Student Worksheet #5 using the Briggs and Stratton Repair Instruction Manual IV as an introduction to disassembly, repair, and reassembly activities.

17. Refer to problem area *Identifying and Using Agricultural Tools and Equipment* as a reference for specific tools and safety practices.

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INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agricultural Engineering/Mechanization

PROBLEM AREA: Understanding and Maintaining Small Engines

REFERENCES

*1. *Small Engines —Principles of Operation, Trouble Shooting & Tune-Up* (VAS Unit #U3014); *Small Engines —Repair & Overhaul* (VAS Unit #U3019); *The Two-Cycle Engine* (VAS Unit #U3020); *Micrometers & Related Measuring Tools* (VAS Unit #U3023); *Small Gas Engines* (VAS Transparency Set #T489); *Small Engine Parts & Functions —Fuel Air Induction* (VAS Filmstrip #F486-1); *Small Engine Parts & Functions —Compression* (VAS Filmstrip #F486-2); *Ignition Systems* (VAS Filmstrip #F486-3); *Exhaust, Lubrication, Cooling and Tools* (VAS Filmstrip #F486-4). Vocational Agriculture Service, College of Agriculture, University of Illinois, 1401 S. Maryland Drive, Urbana, IL 61801. (217) 333-3871.

*2. *General Theories of Operation; Repair Instruction IV*; *Small Engine Flip Charts.* Briggs and Stratton Corporation, Milwaukee, WI.

NOTE: The Briggs and Stratton Materials can be ordered through Midwest Engine Warehouse, 515 Romans Road, Elmhurst, IL 60126. Any school offering a small engine course can receive enough copies of *General Theories of Operation* and *Repair Instruction IV,* manuals for the entire class plus one flip chart and one engine, free of charge. Additional engines, parts, and tools can be purchased through them at a reduced educational discount price.

3. *Principles of Technology.* Curriculum Publications Clearing House, Western Illinois University, Horrabin Hall 46, Macomb, IL 61455. (800) 322-3905 or (309) 298-1917.

4. *Experiments, Demonstrations, and Laboratory Activities for Illustrating Science Applications in Agriculture.* Osborne, Edward W., Project Director, October 1988. Agricultural Education, 124 Mumford Hall, 1301 W. Gregory, Urbana, IL 61801. (217) 333-3166.

*5. *Compact Equipment Series.* John Deere Distribution Service Center, Service Publication, Department 150, 1400 13th, East Moline, IL 61244. (309) 765-2967.

*Indicates highly recommended reference

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTIONAL RESOURCES

These resources are intended for use by teachers in planning and teaching the materials for this problem area and may be adapted to fit the teaching method(s) used.

INFORMATION SHEET #1 — Sources of Information

TRANSPARENCY MASTER #1 — Operation of the Four-Stroke Cycle Engine (with discussion guide)

TRANSPARENCY MASTER #2 — Operation of the Two-Stroke Cycle Engine (with discussion guide)

TRANSPARENCY MASTER #3 — Piston Displacement (with discussion guide)

TRANSPARENCY MASTER #4 — Valve Parts Named (with discussion guide)

TRANSPARENCY MASTER #5 — Parts of Magneto Ignition System (with discussion guide)

TRANSPARENCY MASTER #6 — Flywheel-Type Magneto (with discussion guide)

TRANSPARENCY MASTER #7 — Magneto Ignition Operation I (with discussion guide)

TRANSPARENCY MASTER #8 — Magneto Ignition Operation II (with discussion guide)

TRANSPARENCY MASTER #9 — Magneto Ignition Operation III (with discussion guide)

TRANSPARENCY MASTER #10 — Parts of Solid State Ignition System (with discussion guide)

TRANSPARENCY MASTER #11 — Parts of Solid State Ignition System (with discussion guide)

TRANSPARENCY MASTER #12 — Solid State Ignition Operation I (with discussion guide)

TRANSPARENCY MASTER #13 — Solid State Ignition Operation II (with discussion guide)

TRANSPARENCY MASTER #14 — Solid State Ignition Operation III (with discussion guide)

TRANSPARENCY MASTER #15 — Fuel Supply Systems on Four-Cycle Engine (with discussion guide)

TRANSPARENCY MASTER #16 — Carburetor System on Two-Cycle Engine (with discussion guide)

TRANSPARENCY MASTER #17 — Carburetor System on Two-Cycle Engine (with discussion guide)

INFORMATION SHEET #1

Sources of Information

Manufacturers:

1. Tecumseh Products Company, Parts Depot Division, Grafton, WI 53024.
2. Kohler Company, Kohler, WI 53044.
3. Jacobsen Manufacturing Company, 1712 Packard Avenue, Racine, WI 53403.
4. Johnson Outboards, 200 Sea Horse Drive, Waukegan, IL 60085.
5. Lawn Boy, P.O. Box 82409, Lincoln, NE 68501.
6. Clinton Engines Corporation, Maquoketa, IA 52060.
7. Homelite Division of Textron Inc., Port Chester, NY 10573.
8. McCulloch Corporation, Los Angeles, CA 90009.
9. Teledyne Wisconsin Motor Company, 1910 South 53rd Street, Milwaukee, WI 53219.

Instructional Materials:

1. HOBAR Publications, 1234 Tiller Lane, St. Paul, MN 55112. (612) 633-3170.

   The following computer programs are available:

   a. Briggs and Stratton, *Engine Model Number and Overhaul Specifications,* #AP2-A6300.

   b. Briggs and Stratton, *Small Engine Part Numbers,* #AP2-A6298.

   c. Briggs and Stratton, *Tecumseh Model Number and Overhaul Specifications,* #AP2-Ag299.

   d. Briggs and Stratton, *Small Gas Engines and Related Review,* AP2-A6301 and IBM-A6301.

   The following reference texts are available:

   a. *Small Gas Engines,* #498-3.

   b. *Small Gasoline Engines,* #2242-9.

   c. *Small Engines Service,* #SES-15.

2. AAVIM, Curriculum Publications Clearinghouse, Horrabin Hall 47, Western Illinois University, Macomb, IL 61455. (800) 322-3905 or (309) 298-1917.

   a. *Care and Operation of Small Gasoline Engines,* #108 (Manual) and #108CS-1 (Computer Program).

   b. *Small Engines, Operation, Maintenance and Repair,* #110 (Manual).

   c. *Small Engines Vol. 1,* #108CS (Computer Program).

   d. *Small Gas Engine Parts Identification,* #110CS (Apple Computer Program).

3. Career Aids, 20417 Nordhoff Street, Department MR, Chatsworth, CA 91311. (800) 341-8200.

   a. *Animated Engines* (Tutorials); *Four Cycle Engine,* #TD0021A (Apple Computer Program); *Two Cycle Engine,* #TD002A (Apple Computer Program); *Diesel Engine,* #TD003A (Apple Computer Program).

   b. *Engine Fundamentals,* #RG100A (Manual and Computer Program).

4. Agri-Farm Publications, 1019 Market Street, P.O. Box 43, Gowrie, IA 50543. (515) 352-3303.

   a. *Engine Maintenance by John Deere,* VHS #5069 (Videotape).

   b. *Content of Engines by John Deere,* #537 (Texts, Compact Equipment Series).

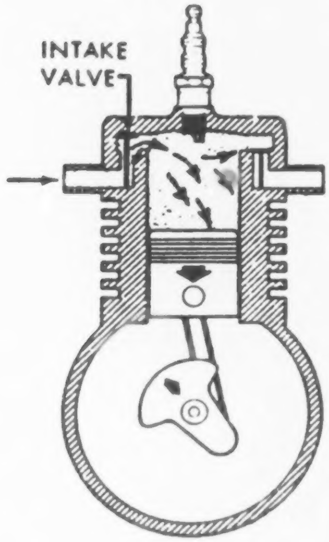
5. Photo Com, P.O. Box 3135, Pismo Beach, CA 93449.

   a. *4-Cycle Engine,* #49-100-01A, (Apple Computer Program).

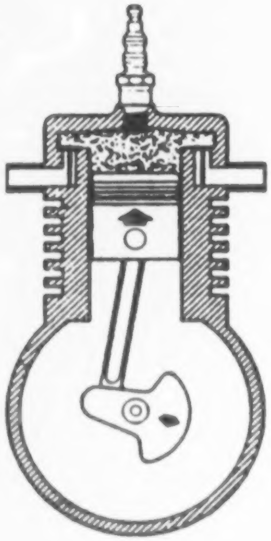
   b. *2-Cycle Engine,* #49-100—2A (Apple Computer Program).

TRANSPARENCY MASTER #1

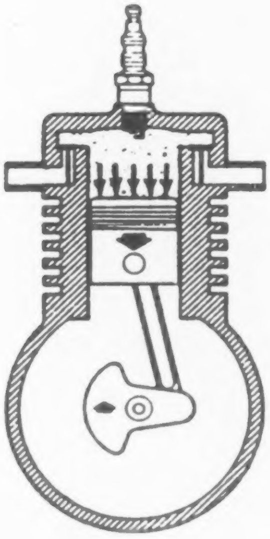
Operation of the Four-Stroke Cycle Engine



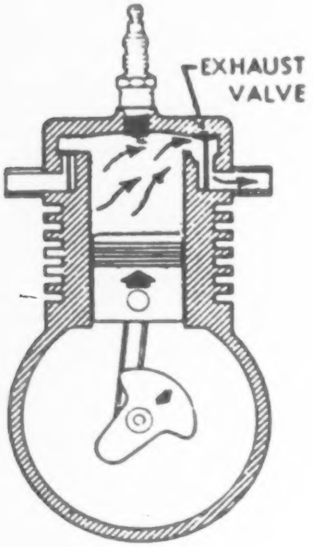
A. Intake Stroke



B. Compression Stroke



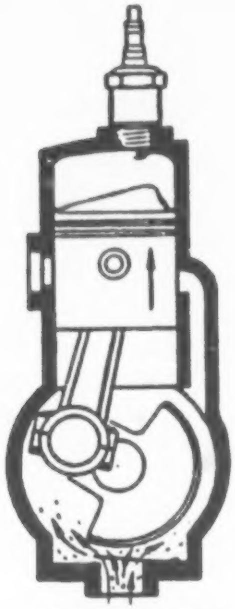
C. Power Stroke



D. Exhaust Stroke

TRANSPARENCY MASTER #2

Operation of the Two-Stroke Cycle Engine



INTAKE
Fig. 1

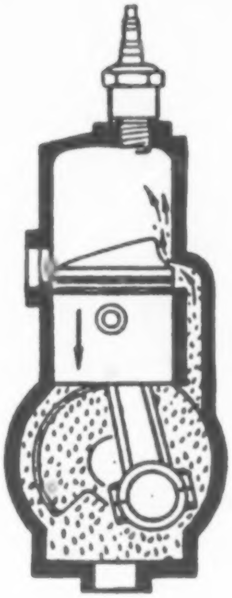
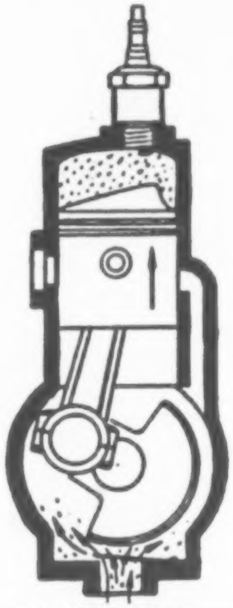
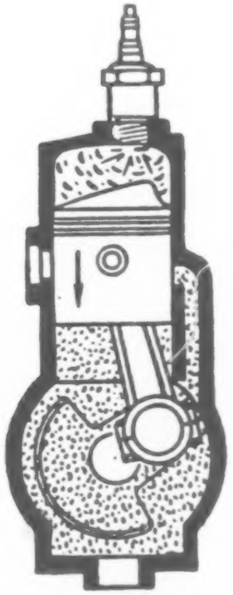


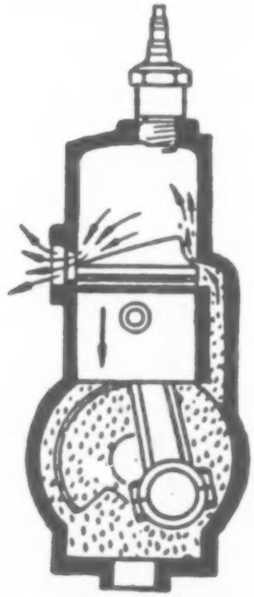
Fig. 2



COMPRESSION
Fig. 3



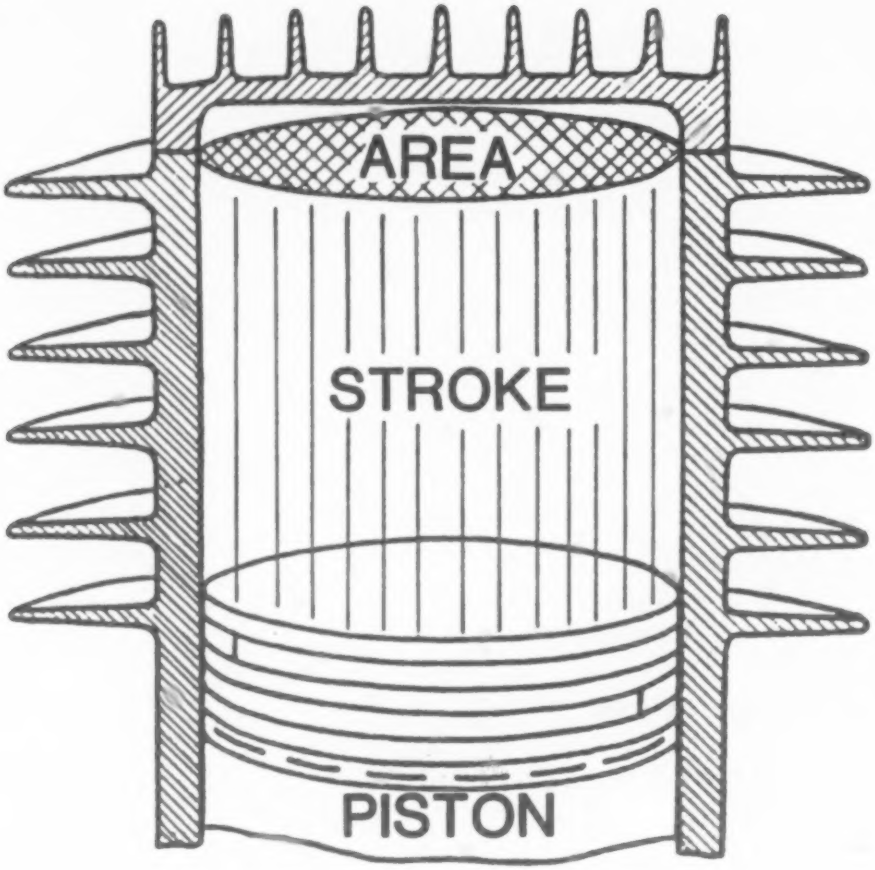
POWER
Fig.4



EXHAUST
Fig.5

TRANSPARENCY MASTER #3

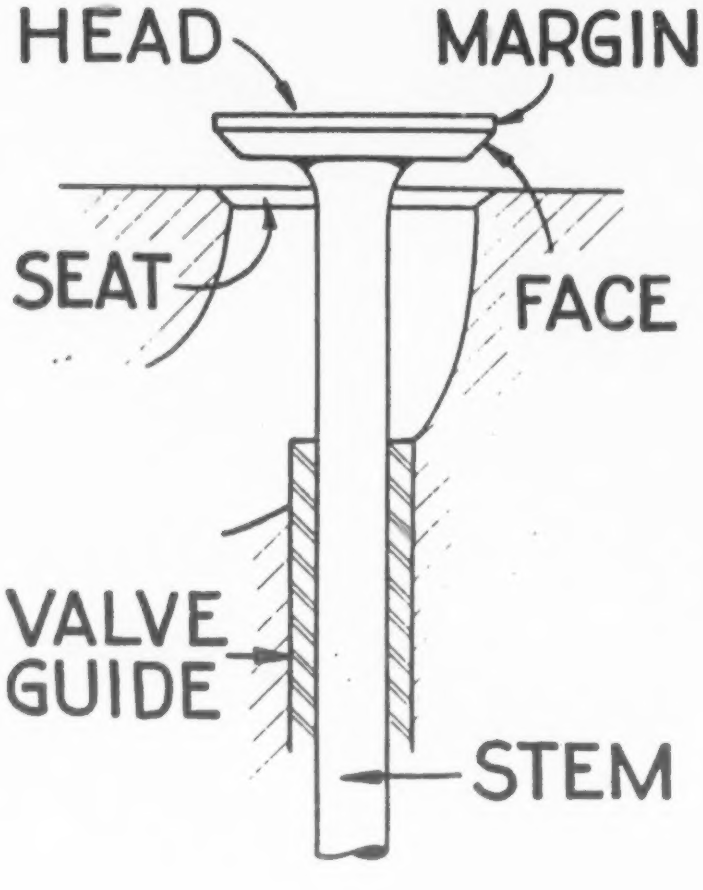
Piston Displacement



Piston Displacement = (Bore^2 ÷ 4) x 3.1416 x Stroke

TRANSPARENCY MASTER #4

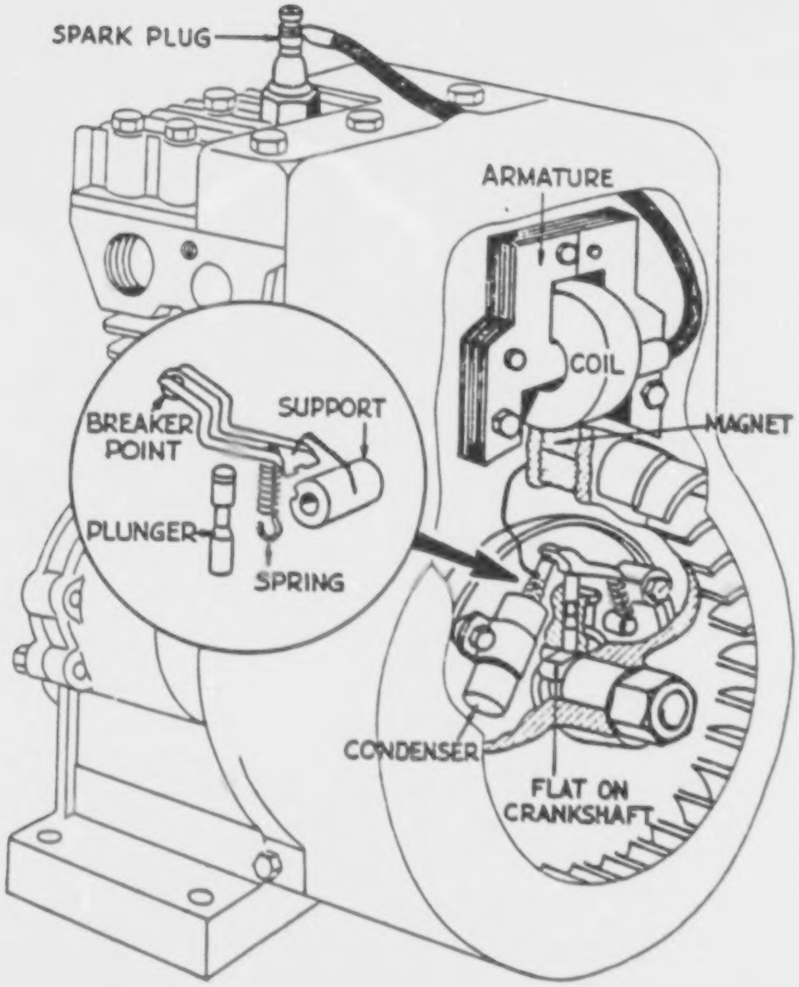
Valve Parts Named


HEAD
MARGIN
SEAT
FACE
VALVE GUIDE
STEM

1623

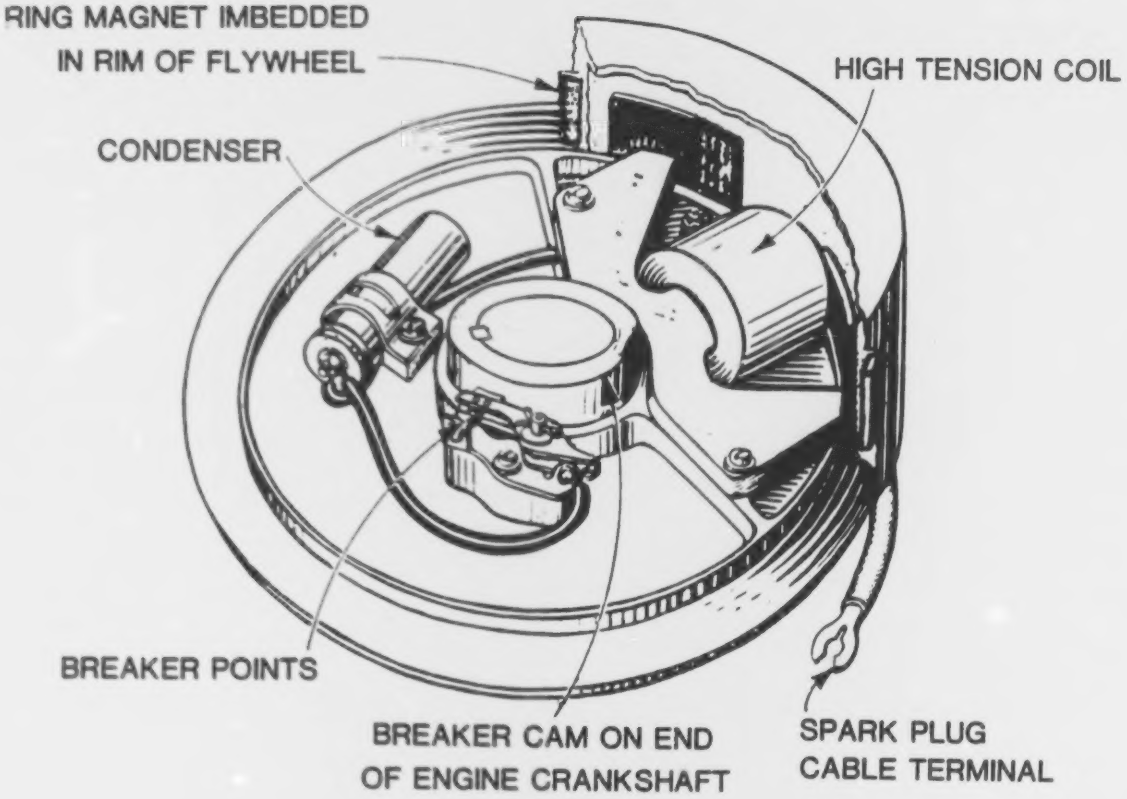
TRANSPARENCY MASTER #5

Parts of Magneto Ignition System


SPARK PLUG
ARMATURE
COIL
MAGNET
BREAKER POINT
SUPPORT
PLUNGER
SPRING
CONDENSER
FLAT ON CRANKSHAFT

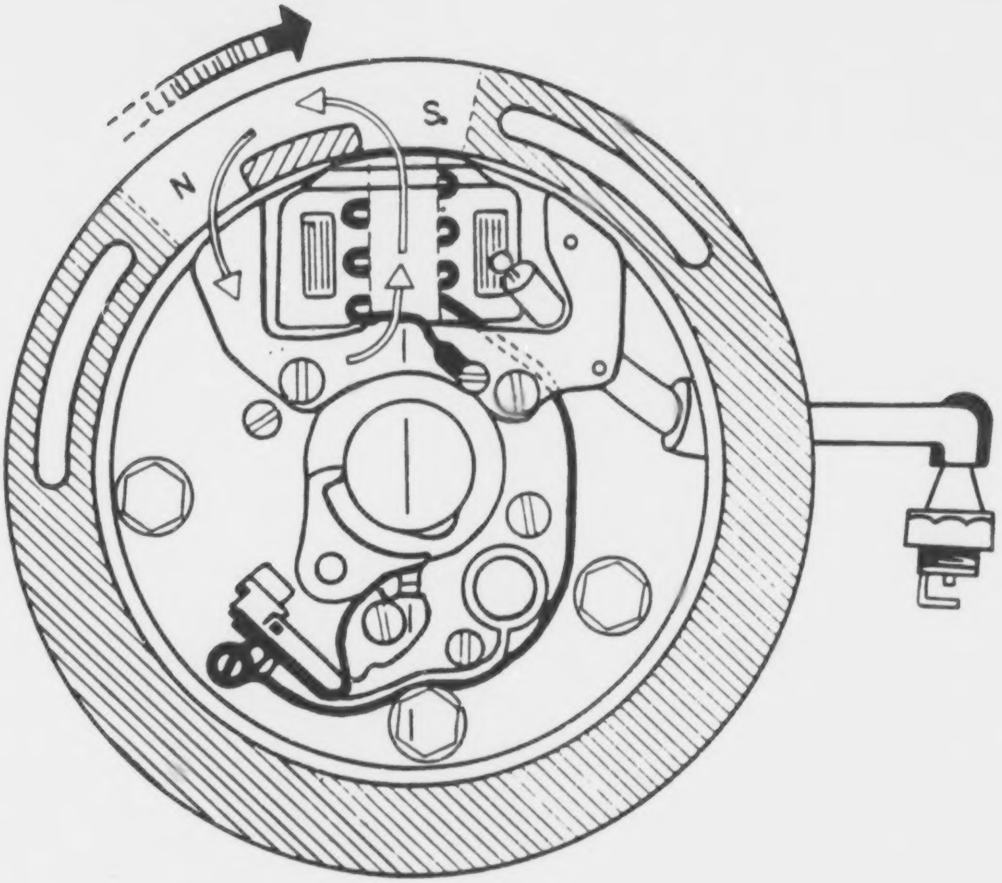
TRANSPARENCY MASTER #6

Flywheel-Type Magneto


RING MAGNET IMBEDDED
IN RIM OF FLYWHEEL
HIGH TENSION COIL
CONDENSER
BREAKER POINTS
BREAKER CAM ON END
OF ENGINE CRANKSHAFT
SPARK PLUG
CABLE TERMINAL

TRANSPARENCY MASTER #7

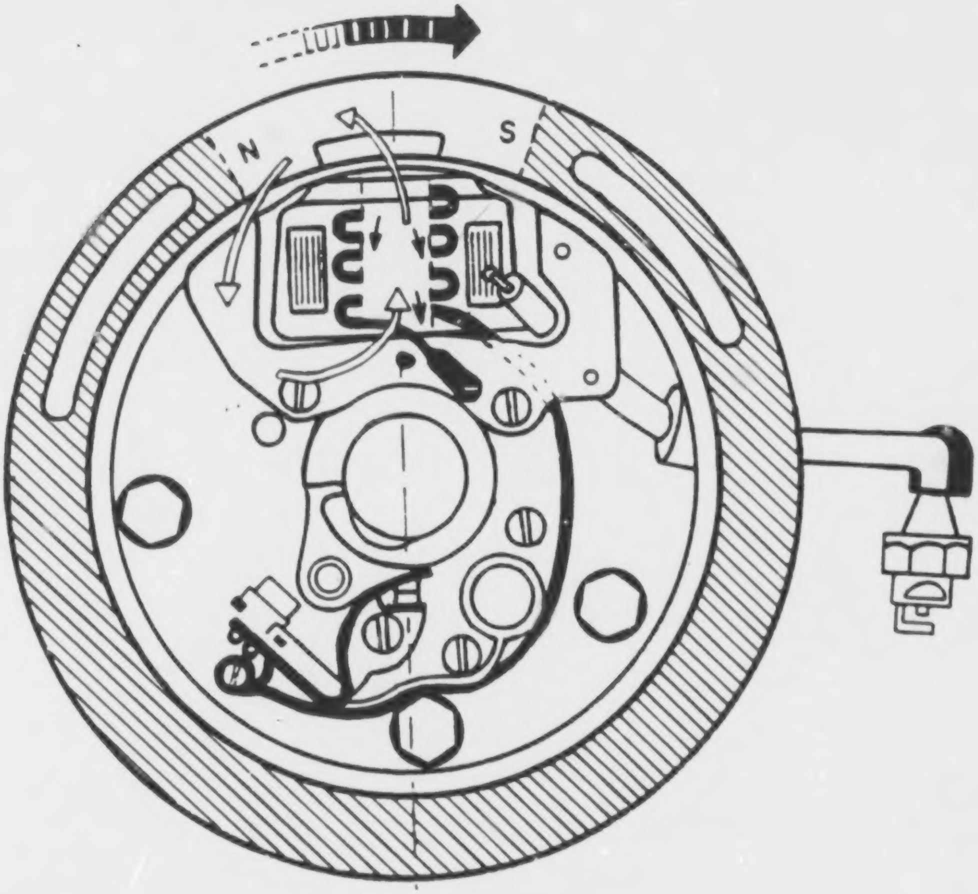
Magneto Ignition Operation I



1626

TRANSPARENCY MASTER #8

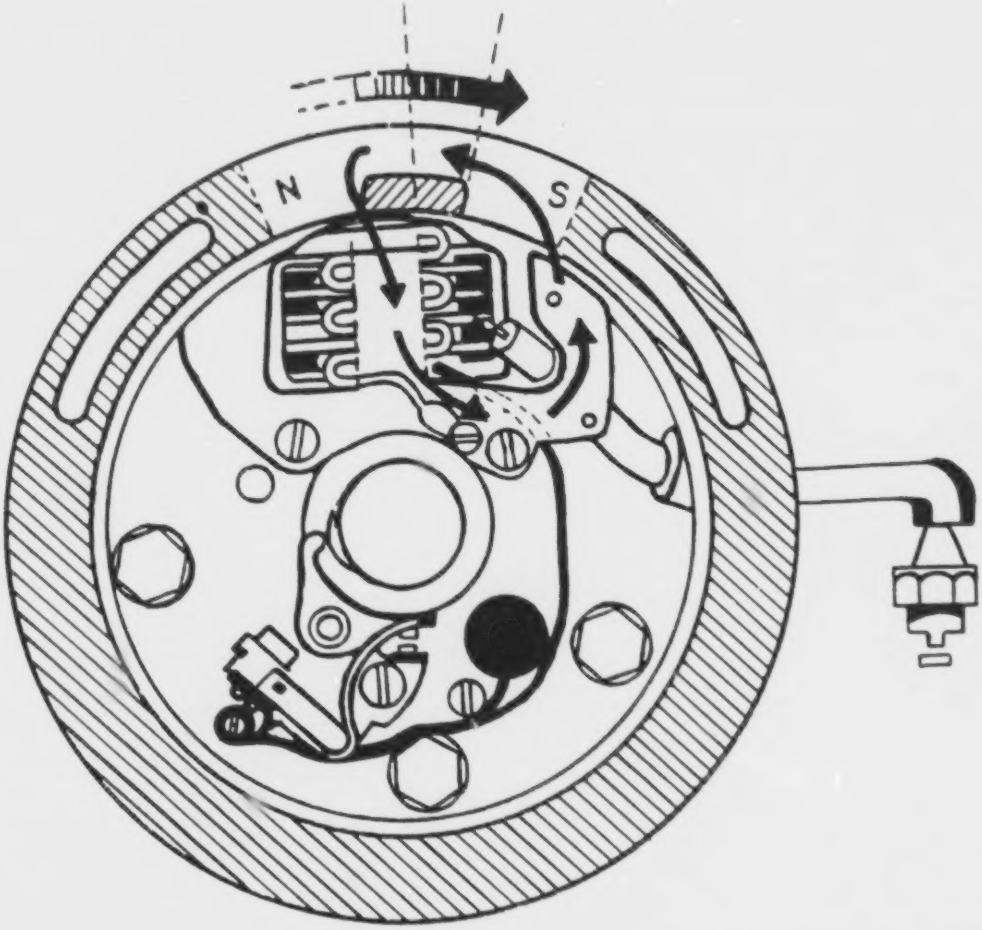
Magneto Ignition Operation II



POINTS ABOUT TO OPEN

TRANSPARENCY MASTER #9

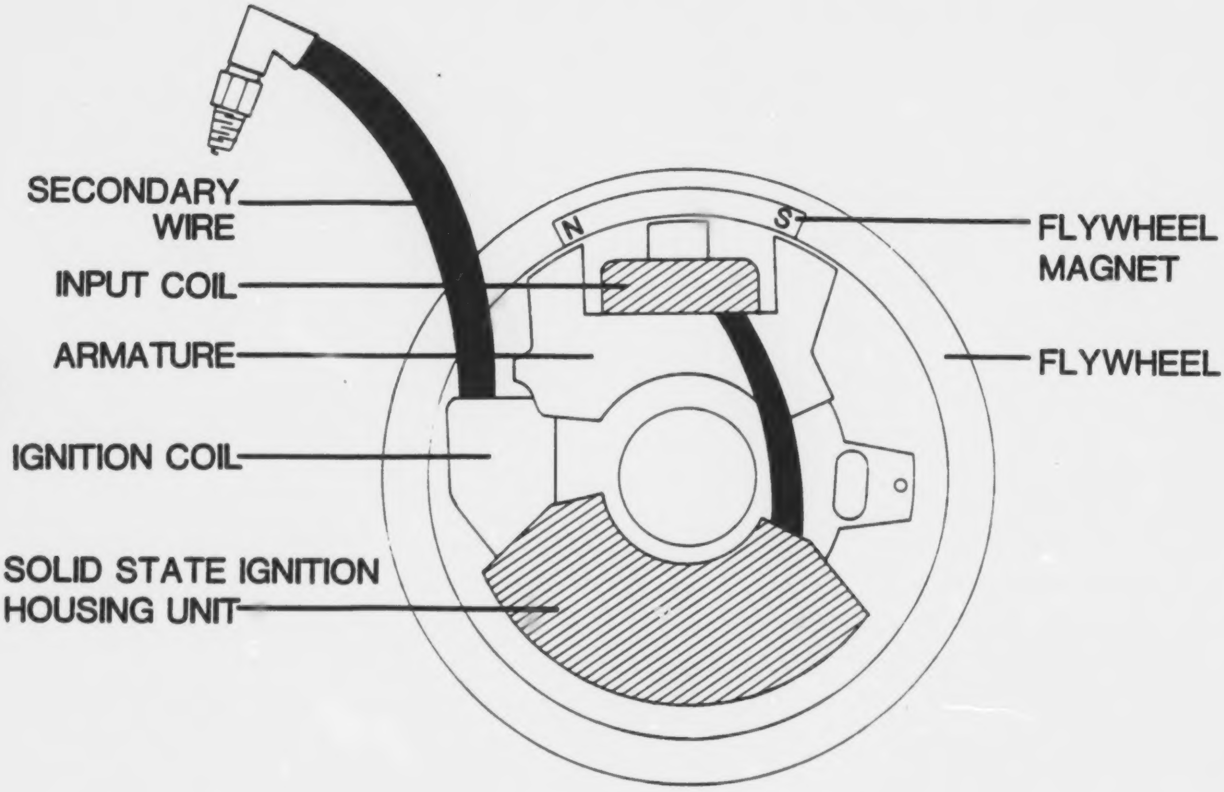
Magneto Ignition Operation III



POINTS OPEN

TRANSPARENCY MASTER #10

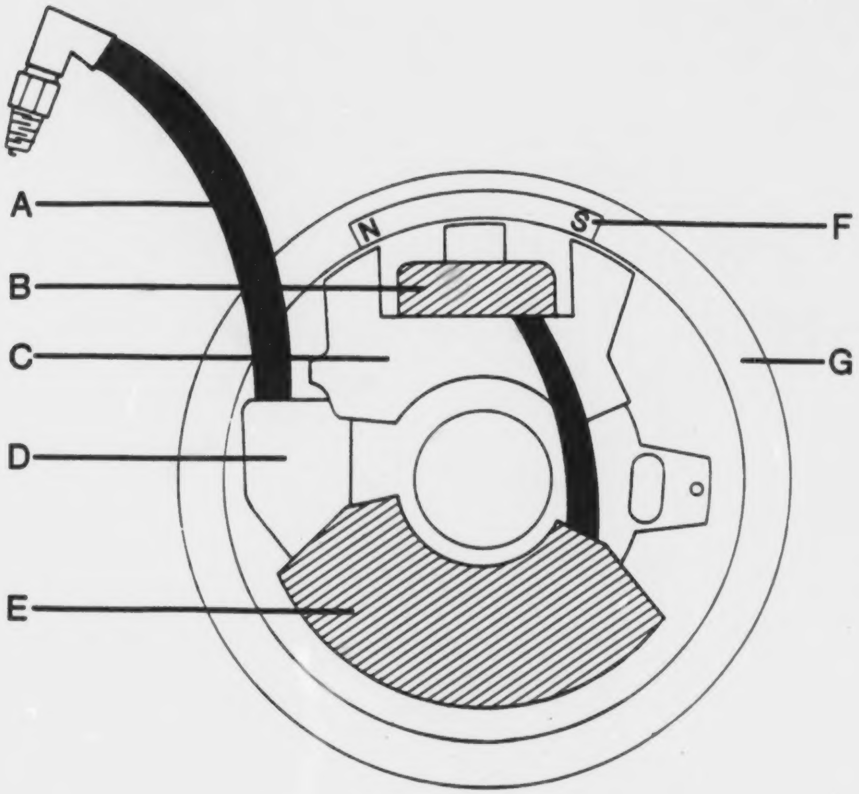
Parts of Solid State Ignition System


SECONDARY WIRE
INPUT COIL
ARMATURE
IGNITION COIL
SOLID STATE IGNITION HOUSING UNIT
N
S
FLYWHEEL MAGNET
FLYWHEEL

1629

TRANSPARENCY MASTER #11

Parts of Solid State Ignition System

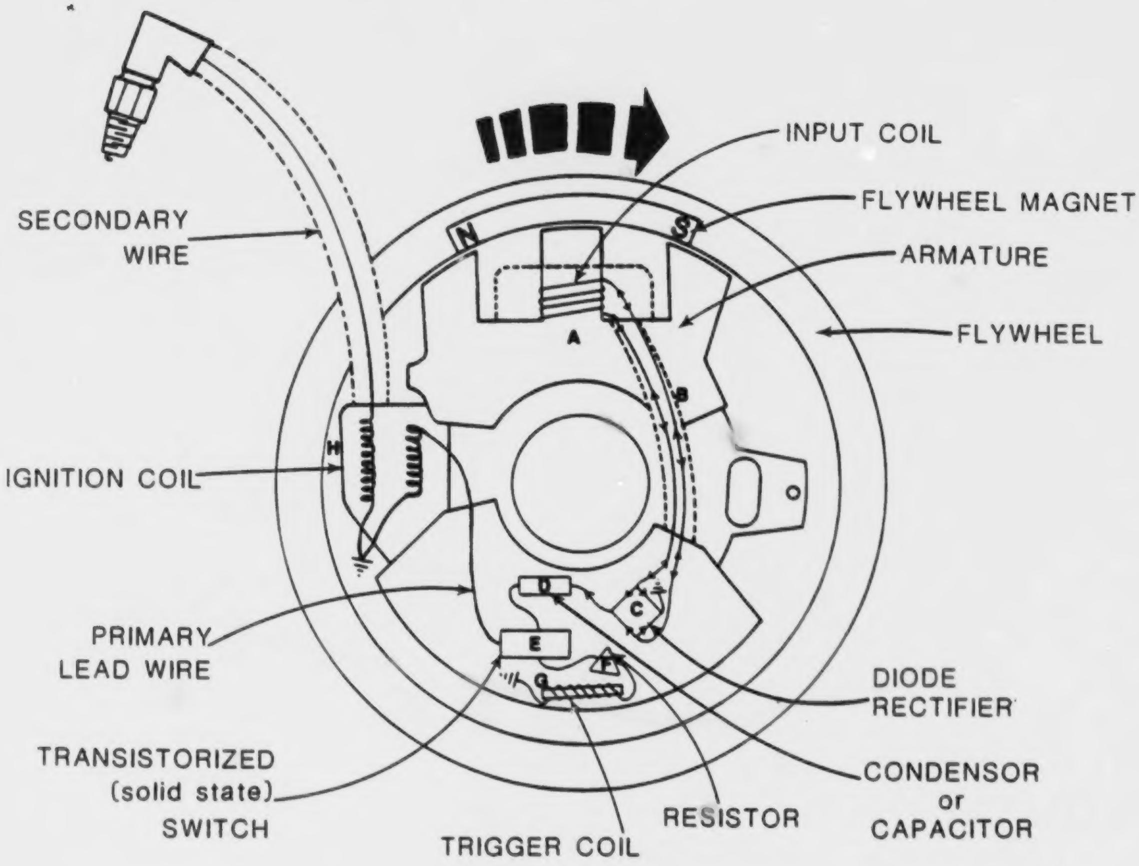


1630

TRANSPARENCY MASTER #12

Solid State Ignition Operation I

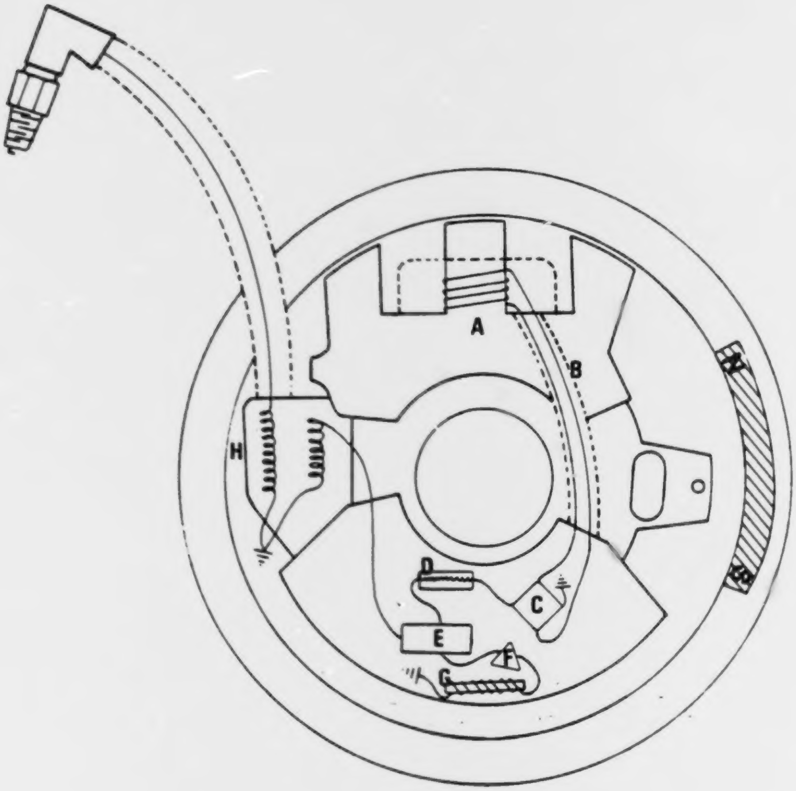
Electrical current is developed at the input coil.


INPUT COIL
FLYWHEEL MAGNET
ARMATURE
FLYWHEEL
SECONDARY WIRE
N
S
A
B
H
IGNITION COIL
C
D
E
F
G
PRIMARY LEAD WIRE
DIODE RECTIFIER
TRANSISTORIZED (solid state) SWITCH
CONDENSOR or CAPACITOR
RESISTOR
TRIGGER COIL

TRANSPARENCY MASTER #13

Solid State Ignition Operation II

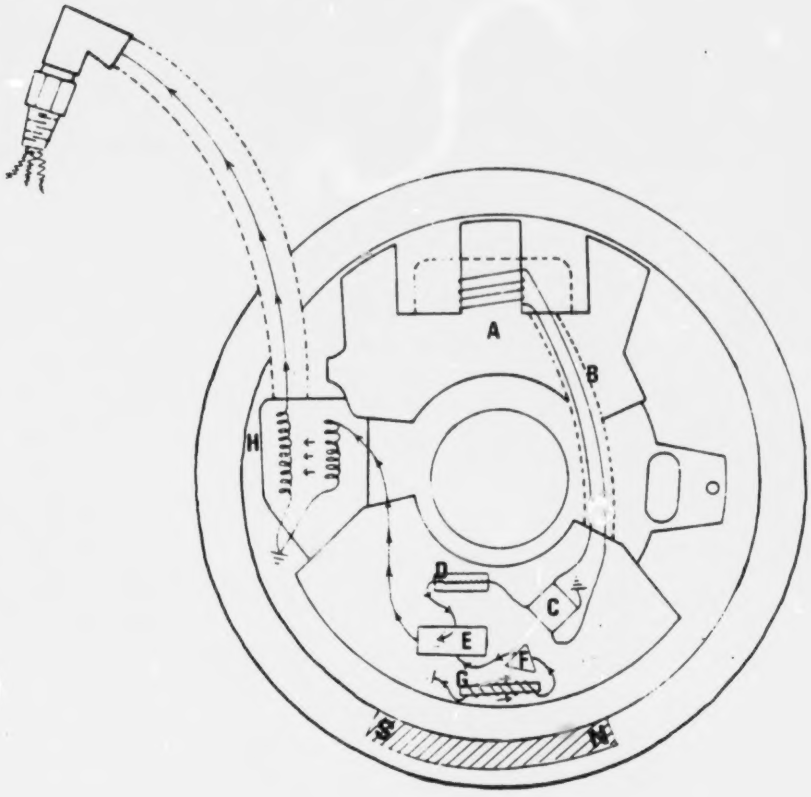
Electrical charge is stored in the condensor.



TRANSPARENCY MASTER #14

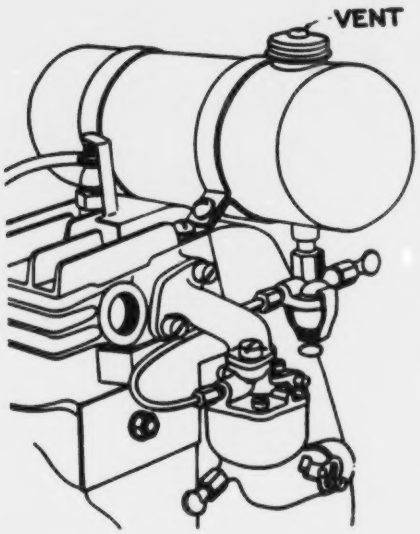
Solid State Ignition Operation III

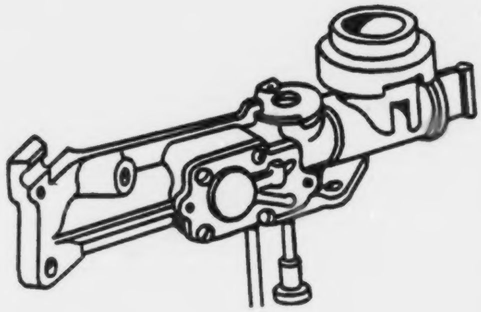
The switch opens and electrical current moves to the ignition coil and spark occurs at the spark plug.



TRANSPARENCY MASTER #15

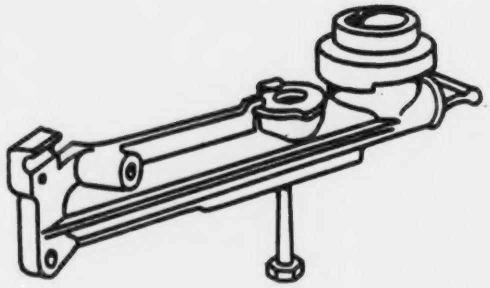
Fuel Supply Systems on Four-Cycle Engine





1. Gravity System

2. Pump System

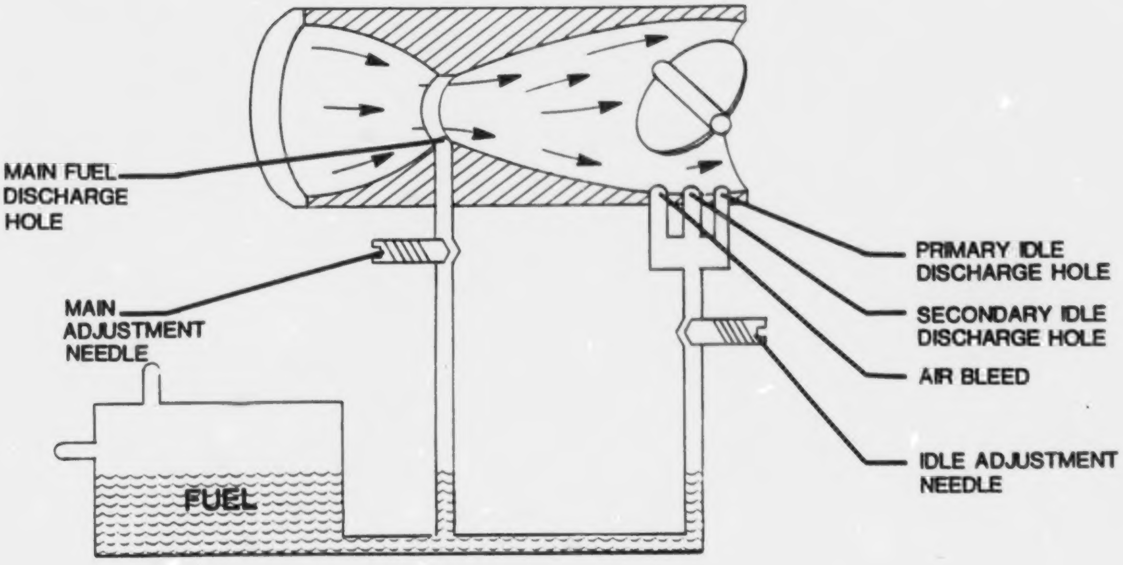


3. Suction System

1634

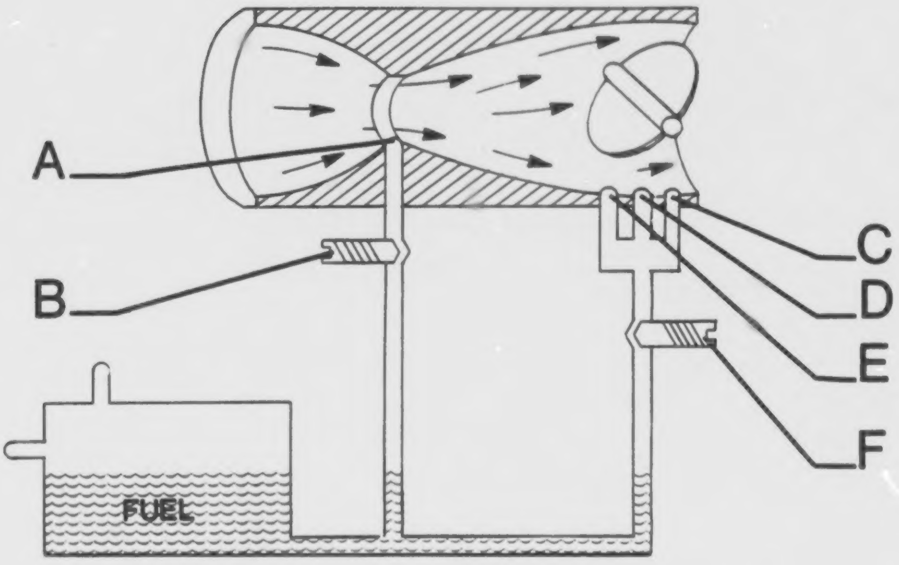
TRANSPARENCY MASTER #16

Carburetor System on Two-Cycle Engine


MAIN FUEL DISCHARGE HOLE
MAIN ADJUSTMENT NEEDLE
FUEL
PRIMARY IDLE DISCHARGE HOLE
SECONDARY IDLE DISCHARGE HOLE
AIR BLEED
IDLE ADJUSTMENT NEEDLE

TRANSPARENCY MASTER #17

Carburetor System on Two-Cycle Engine



1636

TRANSPARENCY MASTER DISCUSSION GUIDE

Transparency Masters #1 and #2

1. Define and explain the events that take place during each stroke of a four-cycle and a two-cycle engine.
2. Discuss the sequenced events that make up a complete cycle.

Transparency Master #3

1. Explain how displacement is a measure of the quantity of fuel-air mixture that can be taken into the cylinder on the intake stroke.
2. Use the formula on the transparency to show how displacement is computed in cubic inches.
3. Point out how changing the bore and/or stroke or the shape of the piston top can change the displacement.

Transparency Master #4

1. Use this transparency to supplement the information in the worksheets.
2. Point out the function of the valves and what should be looked for when inspecting each part of the valve during overhaul.
3. Have students examine various valves and determine if they are usable or should be replaced.
4. Have students practice grinding or lapping used valves.

Transparency Masters #5 and #6

1. Use these transparencies to supplement the information needed in the worksheets.
2. Point out the various parts of the magneto ignition system.
3. Explain and discuss the functions of each part in providing electrical current to the spark plug at the proper time.

Transparency Master #7

1. Point out the position of the flywheel magnet in relation to the coil and armature.
2. Discuss the relationship between a magnetic field and an electric coil. The magnetic field builds up as the magnets pass closer to the coil.
3. As the magnetic field is built up, with the points closed, a small electrical current will develop in the primary windings of the coil.

Transparency Master #8

1. Point out the clockwise movement of the flywheel magnet.
2. Note that the magnetic flow is starting to move through the center leg and right-hand leg of the armature.
3. This movement reverses the direction of flow through the center leg.
4. The ignition points are still closed and the result of the magnetic field starting to reverse develops a strong voltage in the primary windings of the coil.

Transparency Master #9

1. At the peak flow of the primary current the ignition points open and break the current.
2. There is a surge of current due to the break in the primary circuit which is absorbed by the condenser so the points do not arc as they start to open.
3. This rapid collapse of the magnetic field cuts through the secondary windings in the coil.
4. This induces a very high voltage in the secondary windings which in turn results in current jumping the gap at the spark plug electrodes.
5. Point out the importance of a good flywheel key in relation to ignition timing of these events.

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Transparency Masters #10 and #11

1. Use these transparencies to introduce the parts of the solid state ignition system used on some engines.

2. Point out how this system is similar to the magneto system. It has a magnet in the flywheel, and a coil and armature to generate a low voltage current. It has an ignition coil to generate a high voltage current at the spark plug.

3. Point out that this system does not use ignition points to time the spark, but uses a third coil and a solid state ignition switch which is transistorized to set off the high voltage spark at the plug. These items are contained in the solid state ignition housing unit.

Transparency Master #12

1. Point out that current is developed in the input coil (A) as the magnetic field from the flywheel magnet passes near the armature at (A).

2. This movement of the flywheel magnet establishes a weak alternating current (B).

3. The alternating current enters a diode rectifier (C) which converts the alternating current to direct current.

4. The direct current flows from the diode rectifier (C) to the condenser (D) where it is stored briefly.

Transparency Master #13

1. Point out that the flywheel has rotated and the magnet is no longer near the input coil.

2. The electrical current is now stored in the capacitor waiting on the solid state switch to open (E).

Transparency Master #14

1. Point out that the flywheel has rotated so the flywheel magnet is near the trigger coil (F).

2. The lines of the magnetic field cut through the trigger coil (F) which induces a low voltage.

3. This low voltage current passes through a resistor (G) and enters the solid state switch (E) which is transistorized.

4. The solid state switch (E) opens when it receives the current from the trigger coil (F).

5. This opening of the switch allows the current which is stored in the capacitor (D) to flow to the ignition coil.

6. As the current enters the primary windings of the ignition coil (H) a large voltage is induced into the secondary windings and a spark occurs at the electrodes of the spark plug.

7. Note the importance of having the flywheel magnets properly timed so maximum voltage is produced and the spark will occur at the proper time in the combustion chamber.

8. One advantage of the solid state ignition system is that there are no moving parts rubbing against one another.

9. Another advantage is that there are no ignition points to burn up.

10. Have the students identify other advantages of the solid state ignition system over the magneto ignition system.

11. Have the students identify some disadvantages of the solid state ignition system on small engines.

Transparency Masters #15 - #17

1. Point out the basic parts of each type of carburetor used on four-cycle engines.

2. Discuss the location of the fuel tank on each system used on four-cycle engines.

3. Discuss the operation of the carburetor system used on some two-cycle engines.

4. Point out how the suction is developed on two-cycle and four-cycle engines.

5. Point out where the fuel goes when it leaves the carburetor of the two-cycle engines

STUDENT ACTIVITIES

STUDENT WORKSHEET #1 — Small Engine Operation, Troubleshooting and Tune-Up

STUDENT WORKSHEET #2 — The Two-Cycle Engine

STUDENT WORKSHEET #3 — Small Engine Part Identification

STUDENT WORKSHEET #4 — Tools and Equipment for Small Engine Overhaul

STUDENT WORKSHEET #5 — Small Engines — Repair and Overhaul

STUDENT WORKSHEET #6 — Using Small Engine Measuring Tools

STUDENT WORKSHEET #7 — Four-Cycle and Two-Cycle Engine Specifications

STUDENT WORKSHEET #8 — Four-Cycle Engine Overhaul

STUDENT WORKSHEET #9 — Two-Cycle Engine Overhaul

STUDENT WORKSHEET #10 — Preparing Small Engines for End of Season Storage

STUDENT WORKSHEET #11 — Friction and Lubricant Laboratory

STUDENT WORKSHEET #12 — Gas Physics — Demonstration

STUDENT WORKSHEET #13 — Effect of Pressure on the Boiling Point of a Liquid — Demonstration

STUDENT WORKSHEET #14 — Alcohol Vapor Explosion — Demonstration

STUDENT WORKSHEET #1

Small Engine Operation, Troubleshooting and Tune-Up

1. Four-stroke cycle engines make ________ revolution(s) of the crankshaft for each power stroke of the piston.
2. On the intake stroke, the intake valve ________ while the exhaust valve remains ______________ .
3. During the compression and power stroke both valves are ________ .
4. On the exhaust stroke, the exhaust valve ________while the intake valves remains ___________ .
5. Two-stroke cycle engines make _________ revolution(s) of the crankshaft for each power stroke of the piston.
6. The intake valve of many two-cycle engines is a _________ type which ________ only one way. Other two-cycle engines may have a _______valve which is timed to open when the piston starts moving on the compression stroke.
7. The four-cycle engine may be subject to slightly less trouble in __________and will operate more smoothly at speeds.
8. Two-cycle engines produce more ______ per unit of _______ since there is a power stroke every revolution of the crankshaft.
9. The four distinct strokes for one complete cycle are _________, _________, _________, and _________ .
10. Three primary essentials for the operation of any internal combustion engine are ___________ , ___________ , and ___________ .
11. The true sealing of piston and cylinder walls is done by ____________________ .
12. Upper rings are solid and called __________ rings and the bottom ring is perforated and is called an ________ .
13. Piston displacement refers to the __________displaced by the piston in its travel.
14. Piston displacement = ______________
15. The piston displacement for an engine with a 3-inch bore and 3-inch stroke is__________________ .
16. A comparison between the column of the cylinder when the piston is at the bottom of its stroke and the volume of the cylinder when it is at the top of its stroke is called the___________________ .
17. At high speeds each valve must open and close in _________ of a second or less.
18. List the six parts of the valve system.

    A. ________________________

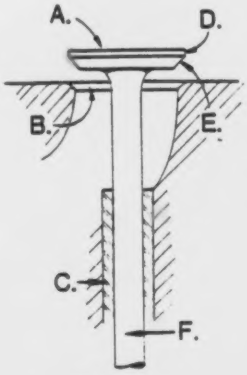
    B. ________________________

    C. ________________________

    D. ________________________

    E. ________________________

    F. ________________________



19. The functions of the carburetor system are to __________ , __________ , __________ , __________ .

20. The parts of the carburetion system include the __________ , __________ , __________ , and __________ .

21. The three types of carburetion systems are __________ , __________ , and __________ .

22. The restricted section of the air passage is called the __________ . Its primary purpose is to __________ velocity of air.

23. Two common types of governors are the __________ and __________ .

24. Most carburetors have a second jet which opens into the air passage just above the butterfly when it is in the closed position. This is called the __________ .

25. Starting a cold engine requires a richer fuel mixture, this is accomplished by closing the __________ .

26. Three types of air cleaners used on small engines are __________ , __________ , and __________ .

27. Small engines generally have a __________ as the source of energy to produce electric spark.

28. Many small engine magnetos are of the __________ type.

29. The ends of the primary coil windings are connected to the __________ and the ends of the secondary coil windings are connected to the __________ .

30. In small engines, the points are normally __________ and a spark occurs once every __________ of the crankshaft.

31. Most small engines are __________ cooled rather than liquid cooled.

32. The __________ provides the small engine with a fan for cooling.

33. The three types of lubrication systems found in four-cycle engines are __________ , __________ , and __________ .

34. Low compression in small engines is generally the result of worn __________ or __________ .

35. If compression is satisfactory, the next check is the __________ .

36. If flooding has occurred without an abnormal amount of choking the engine, you may suspect a plugged __________ .

37. Spark plug gaps are checked with a __________ .

38. __________ on the points is a common source of ignition system trouble in small engines.

39. When adjusting the carburetor during the final tune-up, set the __________ adjustment first, then the __________ jet.

STUDENT WORKSHEET #1 — Key

Small Engine Operation, Troubleshooting and Tune-Up

1. Four-stroke cycle engines make *two* revolution(s) of the crankshaft for each power stroke of the piston.
2. On the intake stroke, the intake valve *opens* while the exhaust valve remains *closed*.
3. During the compression and power stroke both valves are *closed*.
4. On the exhaust stroke, the exhaust valve *opens* while the intake valves remains *closed*.
5. Two-stroke cycle engines make *one* revolution (s) of the crankshaft for each power stroke of the piston.
6. The intake valve of many two-cycle engines is a *reed* type which *opens* only one way. Other two-cycle engines may have a *rotary* valve which is timed to open when the piston starts moving on the compression stroke.
7. The four-cycle engine may be subject to slightly less trouble in *starting* and will operate more smoothly at *slow* speeds.
8. Two-cycle engines produce more *power* per unit of *weight* since there is a power stroke every revolution of the crankshaft.
9. The four distinct strokes for one complete cycle are *intake, compression, power*, and *exhaust*.
10. Three primary essentials for the operation of any internal combustion engine are *compression, carburetion*, and *ignition*.
11. The true sealing of piston and cylinder walls is done by *piston rings*.
12. Upper rings are solid and called *compression* rings and the bottom ring is perforated and is called an *oil*.
13. Piston displacement refers to the *space* displaced by the piston in its travel.
14. Piston displacement = (Bore^2 + 4) x 3.1416 x Stroke
15. The piston displacement for an engine with a 3-inch bore and 3-inch stroke is *21.2 cubic inches*.
16. A comparison between the column of the cylinder when the piston is at the bottom of its stroke and the volume of the cylinder when it is at the top of its stroke is called the *compression ratio*.
17. At high speeds each valve must open and close in *1/50* of a second or less.
18. List the six parts of the valve system.

    A. *Head*
    B. *Seat*
    C. *Valve Guide*
    D. *Margin*
    E. *Face*
    F. *Stem*

19. The functions of the carburetor system are to *atomize fuel, mix fuel and air, vaporize mixture, deliver mixture to cylinders* .
20. The parts of the carburetion system include the *air inlet, carburetor, fuel tank*, and *intake ports.*

21. The three types of carburetion systems are *float, suction,* and *diaphragm*.

22. The restricted section of the air passage is called the *venturi*. Its primary purpose is to *increase* the velocity of air.

23. Two common types of governors are the *air-vane* and *centrifugal*.

24. Most carburetors have a second jet which opens into the air passage just above the butterfly when it is in the closed position. This is called the *idle jet*.

25. Starting a cold engine requires a richer fuel mixture, this is accomplished by closing the *choke*.

26. Three types of air cleaners used on small engines are *oil bath, oil saturated,* and *dry element*.

27. Small engines generally have a *magneto* as the source of energy to produce electric spark.

28. Many small engine magnetos are of the *flywheel* type.

29. The ends of the primary coil windings are connected to the *breaker points* and the ends of the secondary coil windings are connected to the *spark plug*.

30. In small engines, the points are normally *open* and a spark occurs once every *revolution* of the crankshaft.

31. Most small engines are *air* cooled rather than liquid cooled.

32. The *flywheel* provides the small engine with a fan for cooling.

33. The three types of lubrication systems found in four-cycle engines are *dipper splash, oil slinger,* and *oil pump*.

34. Low compression in small engines is generally the result of worn *piston rings* or *valves*.

35. If compression is satisfactory, the next check is the *carburetion*.

36. If flooding has occurred without an abnormal amount of choking the engine, you may suspect a plugged *air cleaner*.

37. Spark plug gaps are checked with a *wire gauge*.

38. *Oil* on the points is a common source of ignition system trouble in small engines.

39. When adjusting the carburetor during the final tune-up, set the *idle speed* adjustment first, then the *main fuel* jet.

STUDENT WORKSHEET #2

The Two-Cycle Engine

1. The two-cycle engine takes two strokes of the piston to go through one cycle. It has no ________________, __________, or ____________.

2. The two-cycle engine uses its ____________ as a fuel mixture transfer pump.

3. The charging of the crankcase, compression of the fuel charge, and ignition must occur on the _________ stroke, where as exhaust and intake occurs on the ________ stroke.

4. The two types of valves used on two-cycle engines are ________ and ________.

5. Lubrication of a two-cycle engine depends on addition of __________ to the _______.

6. The use of ______ grade gasoline is recommended for two-cycle engines.

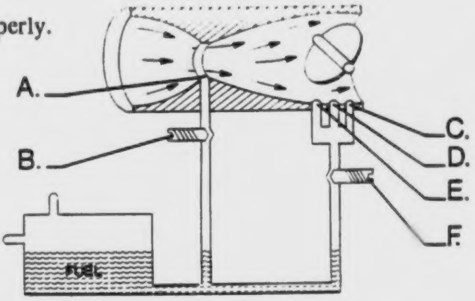
7. A carburetor consists of four parts:

   a. ________________________________
   b. ________________________________
   c. ________________________________
   d. ________________________________

8. A pound of fuel requires ___________ pounds of air to burn properly.

9. Identify the carburetor parts:

   a. ________________________________
   b. ________________________________
   c. ________________________________
   d. ________________________________
   e. ________________________________
   f. ________________________________



10. The ___________ provides an exceedingly rich mixture when starting cold engines.

11. While __________ type carburetors can be used on two-cycle engines, chain saws usually require the ________ type carburetor.

12. The diaphragm-type carburetor can be used in any ___________.

13. The inlet valve can be either a ___________ or __________ type.

14. Chain saw engines make use of ___________ pressures to pump fuel into the carburetor.

15. Because of dirt, chain saw engines are provided with both _____________ and _________filters.

16. Both magnet and battery powered ignition systems require a _______________, _______________, _______________, and ____________.

17. The inner or ___________ winding of the coil contains a few feet of wire whereas the outer or winding contains many feet of very fine wires.

18. The breaker points are two small circular pads of ____________ .

19. The ______________ is used to absorb surges of electricity across the points.

20. The ____________ of a spark plug is very important.

21. The spark plug fires when the ______________ open.

22. When an engine doesn't run or put out full power, check ____________ , ____________ , and ________ .

23. Check the ignition by unscrewing the _____________ , and ________ it by holding the threaded part of the plug to the engine's bare metal.

24. Most carburetor troubles are caused by improper adjustment of the _____________ and __________ adjustment needles.

25. Explain how to check whether the combustion chamber is receiving fuel. ______________________________
____

26. Check engine compression by pulling the starter rope, then slackening the rope and noting the amount of engine ____________ .

27. A compression gauge should indicate at least ______________ pounds of pressure for adequate engine operation.

28. The nine items which should be checked on the ignition system are:

a. ______________________________
b. ______________________________
c. ______________________________
d. ______________________________
e. ______________________________
f. ______________________________
g. ______________________________
h. ______________________________
i. ______________________________

29. The six items which should be checked on the fuel system are:

a. ______________________________
b. ______________________________
c. ______________________________
d. ______________________________
e. ______________________________
f. ______________________________

30. The four things which should be checked for loss of power are:

   a. ____________________
   b. ____________________
   c. ____________________
   d. ____________________

31. Preignition is ____

32. Detonation is ____

STUDENT WORKSHEET #2 — Key

The Two-Cycle Engine

1. The two-cycle engine takes two strokes of the piston to go through one cycle. It has no *camshaft, valve springs*, or *valve lifters*.

2. The two-cycle engine uses its *crankcase* as a fuel mixture transfer pump.

3. The charging of the crankcase, compression of the fuel charge, and ignition must occur on the *upward* stroke, whereas exhaust and intake occurs on the *downward* stroke.

4. The two types of valves used on two-cycle engines are *reed* and *rotary*.

5. Lubrication of a two-cycle engine depends on addition of *oil* to the *fuel*.

6. The use of *regular* grade gasoline is recommended for two-cycle engines.

7. A carburetor consists of four parts:
   a. *Air passage to combustion chamber*
   b. *Fuel opening into carburetor*
   c. *Constant source of fuel*
   d. *An orifice (restriction) in fuel passage line*

8. A pound of fuel requires *15* pounds of air to burn properly.

9. Identify the carburetor parts:
   a. *Main fuel discharge hole*
   b. *Main adjustment needle*
   c. *Primary idle discharge hole*
   d. *Secondary idle discharge hole*
   e. *Air bleed*
   f. *Idle adjustment needle*

10. The *choke* provides an exceedingly rich mixture when starting cold engines.

11. While *float* type carburetors can be used on two-cycle engines, chain saws usually require the *diaphragm* type carburetor.

12. The diaphragm-type carburetor can be used in any *position*.

13. The inlet valve can be either a *ball* or *needle* type.

14. Chain saw engines make use of *crankcase pulsation* pressures to pump fuel into the carburetor.

15. Because of dirt, chain saw engines are provided with both *fuel* and *air* filters.

16. Both magnet and battery powered ignition systems require a *plus, breaker points, condenser*, and *coil*.

17. The inner or *primary* winding of the coil contains a few feet of wire whereas the outer or *secondary* winding contains many feet of very fine wires.

18. The breaker points are two small circular pads of *tungsten*.

19. The *condenser* is used to absorb surges of electricity across the points.

20. The *width* of a spark plug is very important.

21. The spark plug fires when the *breaker points* open.

22. When an engine doesn't run or put out full power, check *ignition, carburetion*, and *compression*.

23. Check the ignition by unscrewing the *spark plug*, and *grounding* it by holding the threaded part of the plug to the engine's bare metal.

24. Most carburetor troubles are caused by improper adjustment of the *main* and *idle* adjustment needles.

25. Explain how to check whether the combustion chamber is receiving fuel. *Hold thumb over spark plug hole and pull starter rope*.

26. Check engine compression by pulling the starter rope, then slackening the rope and noting the amount of engine *rebound*.

27. A compression gauge should indicate at least *90* pounds of pressure for adequate engine operation.

28. The nine items which should be checked on the ignition system are:

    a. *Spark plug*
    b. *Breaker points*
    c. *Loose or shorted wiring*
    d. *Flywheel-armature gap*
    e. *Condenser*
    f. *Coil*
    g. *Magnet*
    h. *Ignition switch*
    i. *Flywheel key*

29. The six items which should be checked on the fuel system are:

    a. *Main fuel needle*
    b. *Idle adjustment needle*
    c. *Fuel inlet valves*
    d. *Fuel pump*
    e. *Fuel filters*
    f. *Air filters*

30. The four things which should be checked for loss of power are:

    a. *Poor compression*
    b. *Dirty or plugged muffler*
    c. *Overheating*
    d. *Valve clearance*

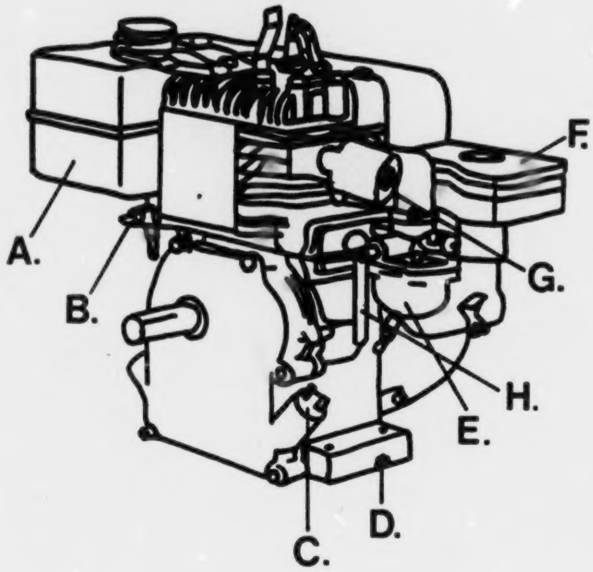
31. Preignition is *Combustion caused before spark plug is timed to fire*.

32. Detonation is *Combustion caused by glowing carbon particles or by hot spots in the combustion chamber*.

STUDENT WORKSHEET #3

Small Engine Part Identification

1. Identify the following parts on the four-cycle small engine:



A. ______________________________

B. ______________________________

C. ______________________________

D. ______________________________

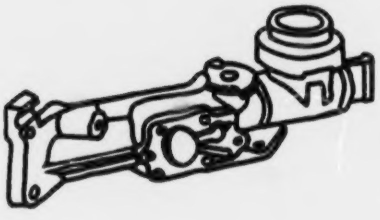
E. ______________________________

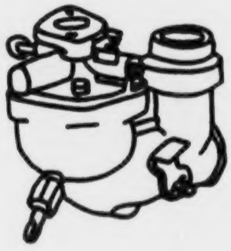
F. ______________________________

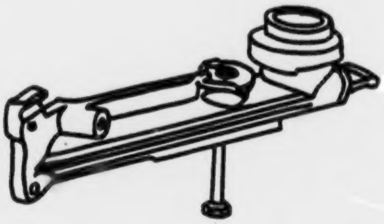
G. ______________________________

H. ______________________________

2. Identify the following carburetors:

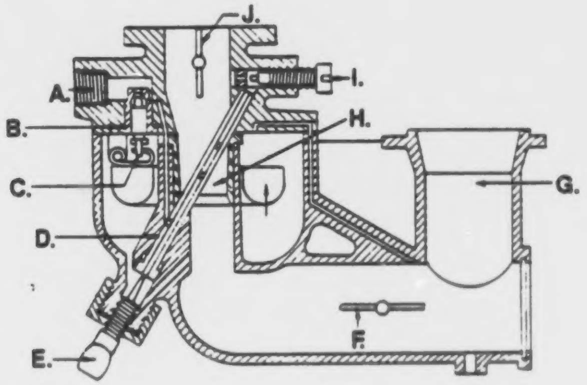






A. ____________________ B. ____________________ C. ____________________

3. Identify the following parts of the carburetor:



A. ______________________ F. ______________________

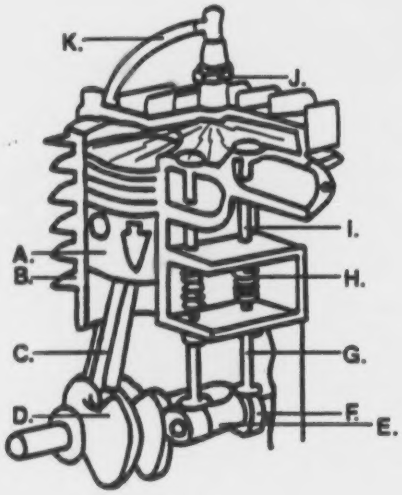
B. ______________________ G. ______________________

C. ______________________ H. ______________________

D. ______________________ I. ______________________

E. ______________________ J. ______________________

4. Identify the following parts of the cut-away engine:



A. ______________________

B. ______________________

C. ______________________

D. ______________________

E. ______________________

F. ______________________

G. ______________________

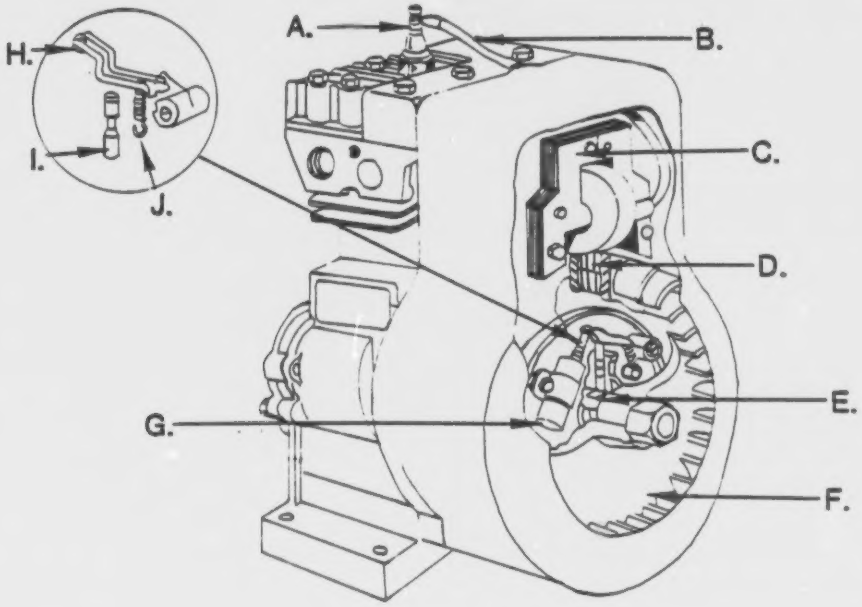
H. ______________________

I. ______________________

J. ______________________

K. ______________________

5. Identify the following parts of the small engine magneto ignition system:



A. ______________________

B. ______________________

C. ______________________

D. ______________________

E. ______________________

F. ______________________

G. ______________________

H. ______________________

I. ______________________

J. ______________________

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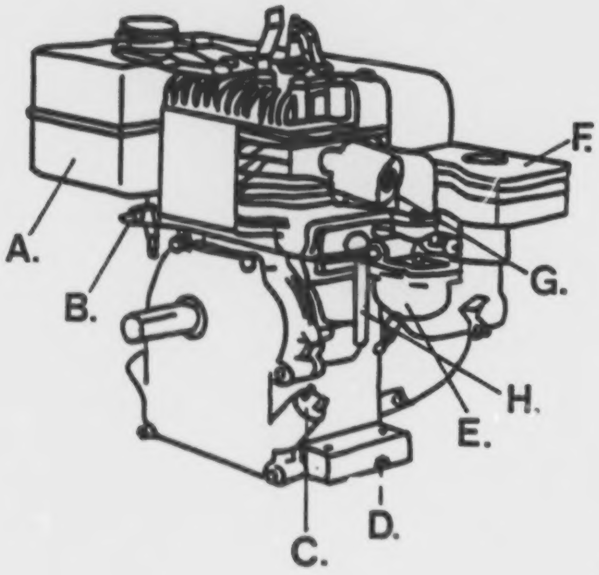
STUDENT WORKSHEET #3 — Key

Small Engine Part Identification

1. Identify the following parts on the four-cycle small engine:



A. *Fuel tank*

B. *Sediment bowl*

C. *Oil filler plug*

D. *Oil drain plug*

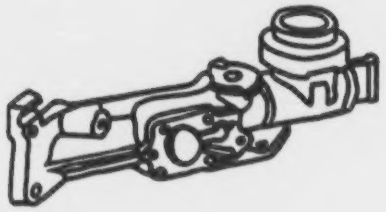
E. *Carburetor*

F. *Air breather*

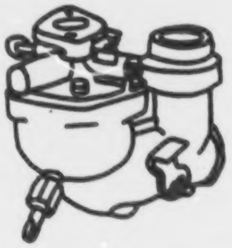
G. *Muffler*

H. *Crankcase breather*

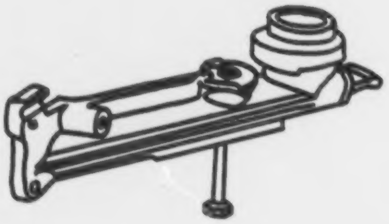
2. Identify the following carburetors:



A. *Diaphragm*



B. *Float*



C. *Suction-lift*

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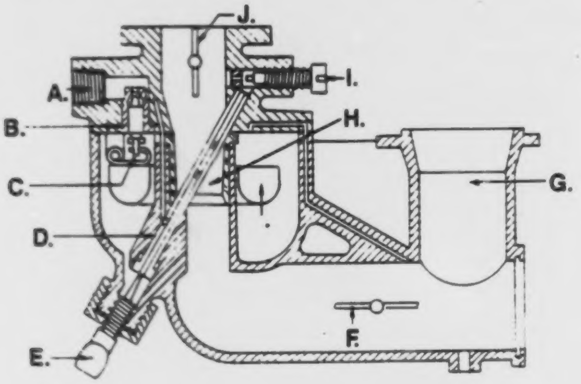
3. Identify the following parts of the carburetor:



A. *Fuel inlet*

B. *Float needle seat*

C. *Float*

D. *Fuel nozzle*

E. *Main needle valve*

F. *Choke valve*

G. *Air horn*

H. *Venturi*

I. *Idle valve*

J. *Throttle valve*

4. Identify the following parts of the cut-away engine:

A. *Piston*

B. *Crankcase (cylinder wall)*

C. *Connecting rod*

D. *Crankshaft*

E. *Camshaft*

F. *Cam lobe*

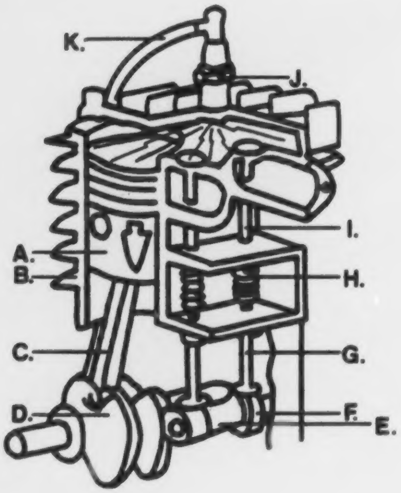
G. *Valve tappet*

H. *Valve spring*

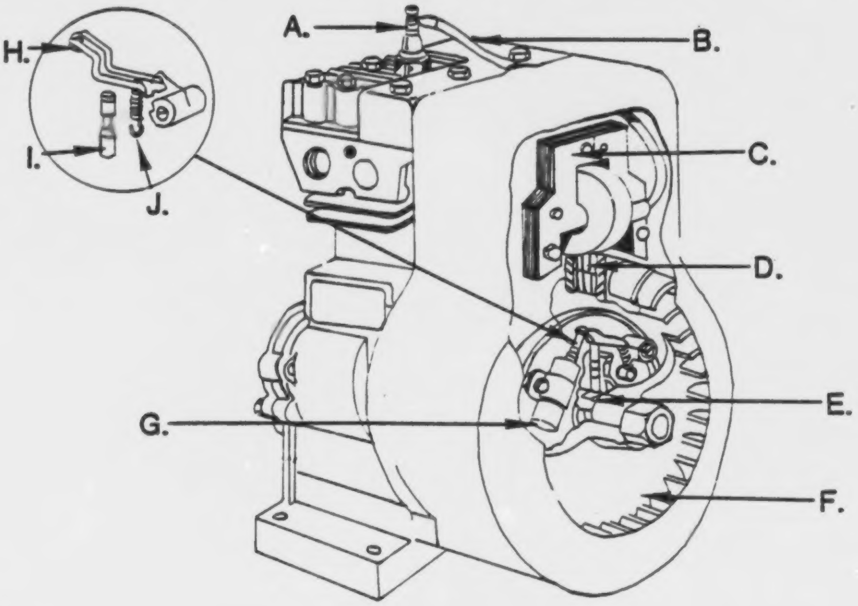
I. *Valves*

J. *Sparkplug*

K. *High tension lead*



5. Identify the following parts of the small engine magneto ignition system:



A. *Spark plug*

B. *High tension lead*

C. *Armature*

D. *Magnet*

E. *Plunger flat*

F. *Flywheel*

G. *Condenser*

H. *Ignition point*

I. *Plunger*

J. *Point spring*

STUDENT WORKSHEET #4

Tools and Equipment for Small Engine Overhaul

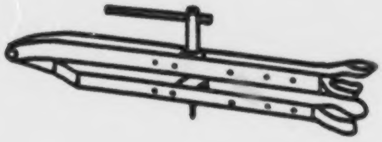
1. A shop-made ____________ holder will fit a variety of engines.
2. A special flywheel holder wrench is used to take off __________ mechanism starters.
3. A flywheel ____________ is used to remove flywheels.
4. A ____________ is used to control valve springs when removing and replacing valves.
5. A ____________ is used for removing and replacing piston rings.
6. A ____________ is used for replacing pistons in the cylinder.
7. The two types of thickness gauges are ____________ and ______________ .
8. Outside micrometers are used to measure ________ , ___________ , and other external ___________.
9. ______________ are used for measuring holes or slats.
10. A ____________ measures engine parts for wear and dimensions.
11. The ___________ can measure the amount of twisting force applied to bolts.
12. A ____________ can be used to remove the carbon ridge at the top of cylinder walls.
13. You should use a ______________ to deglaze cylinder walls before new piston rings are installed.
14. The piston ring gap can be checked with a _______________ .
15. The device used to reface valves and valve seats is a _____________ .
16. Three types of valve repair tools are ____________ , __________________ , and ________________ .
17. The __________ indicator measures crankshaft end play and out-of-roundness.
18. A ____________ gauge checks the engine compression.
19. Reject gauges are used to check _______________ , __________________ , and ________________ .
20. Explain how to use plastigage.

____

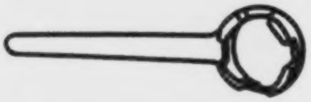
____

____

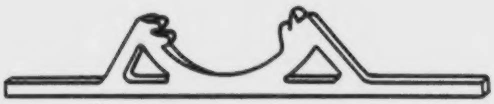
21. Identify the following small engine tools:



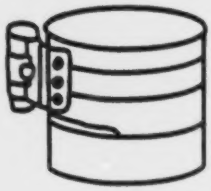
A. ______________________________



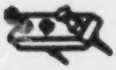
B. ______________________________



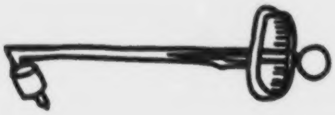
C. ______________________________



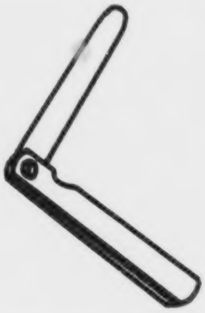
D. ______________________________



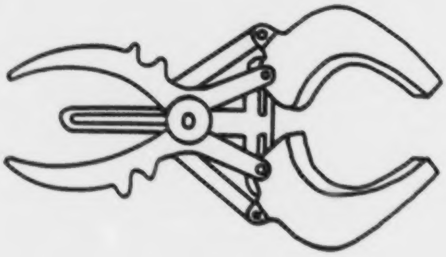
E. ______________________________



F. ______________________________



G. ______________________________



H. ______________________________

STUDENT WORKSHEET #4 — Key

Tools and Equipment for Small Engine Overhaul

1. A shop-made *flywheel* holder will fit a variety of engines.

2. A special flywheel holder wrench is used to take off *recoil* mechanism starters.

3. A flywheel *puller* is used to remove flywheels.

4. A *valve spring compressor* is used to control valve springs when removing and replacing valves.

5. A *piston ring expander* is used for removing and replacing piston rings.

6. A *piston ring compressor* is used for replacing pistons in the cylinder.

7. The two types of thickness gauges are *flat type* and *wire type*.

8. Outside micrometers are used to measure *pistons, bearings*, and other external *parts*.

9. *Telescoping gauges* are used for measuring holes or slats.

10. A *micrometer* measures engine parts for wear and dimensions.

11. The *torque wrench* can measure the amount of twisting force applied to bolts.

12. A *ridge reamer* can be used to remove the carbon ridge at the top of cylinder walls.

13. You should use a *cylinder hone* to deglaze cylinder walls before new piston rings are installed.

14. The piston ring gap can be checked with a *flat feeler gauge*.

15. The device used to reface valves and valve seats is a *valve grinder*.

16. Three types of valve repair tools are *valve grinder, valve seat grinder*, and *valve lapper*.

17. The *dial* indicator measures crankshaft end play and out-of-roundness.

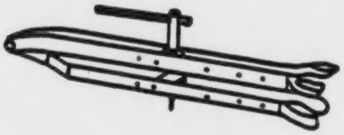
18. A *compression* gauge checks the engine compression.

19. Reject gauges are used to check *bearings, valve guides*, and *breaker point plungers*.

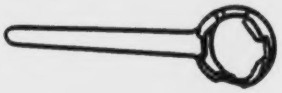
20. Explain how to use plastigage.

    Place small strip on connecting rod cap. Tighten cap on crankshaft to correct torque. Remove and measure Plastigage spread.

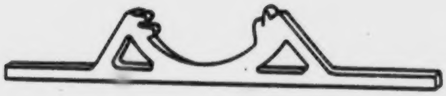
21. Identify the following small engine tools:



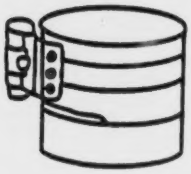
A. *Valve spring compressor*



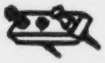
B. *Starter clutch wrench*



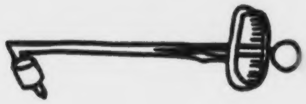
C. *Flywheel holder*



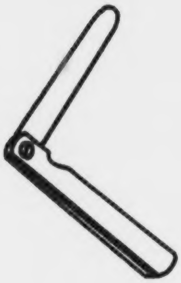
D. *Piston ring compressor*



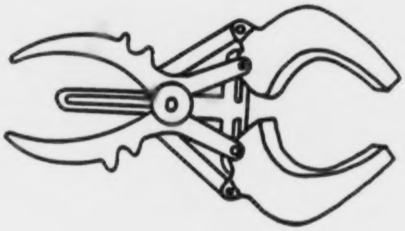
E. *Flywheel puller*



F. *Torque wrench*



G. *Feeler gauge*



H. *Piston ring expander*

STUDENT WORKSHEET #5

Small Engines — Repair and Overhaul

Disassembling the Engine:

1. Before taking the engine apart, ____________ it thoroughly.

2. Drain the ____________ and ____________ from the engine.

3. The eight things which should be removed when disassembling the engine are:
   a. ____
   b. ____
   c. ____
   d. ____
   e. ____
   f. ____
   g. ____
   h. ____

Measuring Cylinder, Piston, and Ring Wear:

1. It is important first to determine the ____________ and amount of ________ in the cylinder.

2. Use a ____________ gauge to measure piston diameter.

3. Explain how to measure the cylinder for out-of-round. ______________________________
____
____

4. Explain how to measure the cylinder taper. ______________________________
____
____

5. Two common reasons for rejecting a piston are:
   a. ____
   b. ____

6. Piston ring end gap should be measured for each ____________ ring and ____________ ring.

Checking Crankshaft and Bearings:

1. The crankspin should be checked for three things: ____________, ____________, and ____________.

2. A convenient way to measure bearing clearance is to use a __________ thread (________).

Replacing the Piston:

1. Before replacing the piston you should ____________ the cylinder wall thoroughly.

2. Clean piston ____________ grooves.

3. Use a ____________ expander to install rings on the piston.

4. The piston of a two-cycle engine may have a small __________ or __________ in each ring groove to keep the ring from turning.

5. Explain how to install the piston in the cylinder.
   a. ______________________________
   b. ______________________________
   c. ______________________________
   d. ______________________________

Servicing The Valves:

1. The four things which should be serviced on the valves are:
   a. ______________________________
   b. ______________________________
   c. ______________________________
   d. ______________________________

Replacing the Engine Head:

1. Use a __________ wrench when tightening the engine head to specifications.

2. ______________ tighten the bolts on one side and the other so that the head is drawn down evenly.

Repairing the Carburetor and Fuel System:

1. The two types of carburetors that should be serviced are the __________ type and ___________ type.

Servicing the Ignition System:

1. If the __________ are pitted or burned they should be replaced.

2. Inspect the spark plug for __________ , ___________ , or __________ .

3. The three kinds of spark to look for when testing the coil and ignition wiring are ______ , _____________ , and _____________ .

4. Magneto air gap is the distance between rotating __________ in the flywheel and the __________laminations of the coil.

5. The two types of coil and armature are ___________ the flywheel and _____________ the flywheel.

6. Specified magneto output should jump a gap of ____________ .

Operating and Checking the Engine:

1. Explain the things which should be installed or adjusted before starting the engine.

____

____

____

____

2. Explain how to set the main fuel and idle screw with the engine running.

____

____

Read the following statements on safety and place and "A" by those statements which would be good "approved practices" to observe:

______ 1. Storing gasoline in approved metal containers.

______ 2. Removing gasoline from the gas tank and carburetor before repairing an engine.

______ 3. Refilling a gasoline tank with the engine running.

______ 4. Working in a well-ventilated shop.

______ 5. Using an approved solvent for cleaning engine parts.

______ 6. Removing the spark plug wire before servicing or repairing an engine.

______ 7. Having dry chemical fire extinguishers available.

______ 8. Following good work habits.

______ 9. Reading and following your operator's and/or service manual.

______ 10. Cleaning the engine before it is serviced.

______ 11. Using gasoline for cleaning engine parts.

______ 12. Working on a hot engine.

______ 13. Storing greasy shop rags in a metal air-tight container.

______ 14. Cleaning wrenches and other tools before storing.

______ 15. Securing the engine in an approved mount before starting to work on the engine.

______ 16. Operating the engine with the governor disconnected.

______ 17. Operating a vertical shaft engine with a special flywheel when adjusting the governor and carburetor.

______ 18. Test-running the engine without the engine shroud which covers the flywheel.

______ 19. Handling volatile fuels in a shop or area which has an open flame.

______ 20. Removing all fuel from an engine before placing it in dry storage.

______ 21. Operating an engine which has gasoline dripping from the fuel system.

______ 22. Operating an engine with the muffler removed.

______ 23. Assembling the engine using bolts and cap screws of the specified grade.

______ 24. Using a starter rope which is not frayed.

______ 25. Using "ether-type" starter fluids to start small engines.

______ 26. Using a torch to repair leaks in a gasoline tank.

______ 27. Operating a vertical shaft lawn mower with a cracked or bent blade.

______ 28. Spilling gasoline on a hot engine.

______ 29. Wearing safety glasses when in the shop.

______ 30. Using an approved flywheel holder when removing a flywheel nut.

______ 31. Keeping hands and face away from the carburetors when cranking an engine if the air cleaner is removed.

STUDENT WORKSHEET #5 — Key

Small Engines — Repair and Overhaul

Disassembling the Engine:

1. Before taking the engine apart, *clean* it thoroughly.

2. Drain the *oil* and *gas* from the engine.

3. The eight things which should be removed when disassembling the engine are:

   a. *Air cleaner*
   b. *Carburetor*
   c. *Fuel tank*
   d. *Flywheel*
   e. *Head*
   f. *Crankcase*
   g. *Piston*
   h. *Valves*

Measuring Cylinder, Piston, and Ring Wear:

1. It is important first to determine the *type* and amount of *wear* in the cylinder.

2. Use a *telescoping* gauge to measure piston diameter.

3. Explain how to measure the cylinder for out-of-round.

   Measure diameter at right angles near the top, middle, and bottom.

4. Explain how to measure the cylinder taper.

   Measure diameter near the top and bottom and subtract measurements.

5. Two common reasons for rejecting a piston are:
   a. *Excessive ring groove wear*
   b. *Excessive piston skirt clearance*

6. Piston ring end gap should be measured for each *compression* ring and *oil* ring.

Checking Crankshaft and Bearings:

1. The crankspin should be checked for three things: *scoring*, *wear*, and *out-of-roundness*.

2. A convenient way to measure bearing clearance is to use a *plastic* thread (*Plastigage*).

Replacing the Piston:

1. Before replacing the piston you should *clean* the cylinder wall thoroughly.

2. Clean piston *ring* grooves.

3. Use a *ring* expander to install rings on the piston.

4. The piston of a two-cycle engine may have a small *pin* or *knob* in each ring groove to keep the ring from turning.

5. Explain how to install the piston in the cylinder.
   a. *Oil cylinder walls and piston*
   b. *Align ring gaps 120 degrees apart*
   c. *Compress rings*
   d. *Slide piston into cylinder*

Servicing the Valves:

1. The four things which should be serviced on the valves are:
   a. *Valve face*
   b. *Valve seat*
   c. *Stem clearance*
   d. *Tappet clearance*

Replacing the Engine Head:

1. Use a *torque* wrench when tightening the engine head to specifications.

2. *Alternately* tighten the bolts on one side and the other so that the head is drawn down evenly.

Repairing the Carburetor and Fuel System:

1. The two types of carburetors that should be serviced are the *float* type and *diaphragm* type.

Servicing the Ignition System:

1. If the *breaker points* are pitted or burned they should be replaced.

2. Inspect the spark plug for *oil deposits, wide gap, or burning*.

3. The three kinds of spark to look for when testing the coil and ignition wiring are *weak spark, inconsistent spark*, and *bright blue spark*.

4. Magneto air gap is the distance between rotating *magnets* in the flywheel and the *stationary* laminations of the coil.

5. The two types of coil and armature are *outside* the flywheel and *inside* the flywheel.

6. Specified magneto output should jump a gap of *0.166 inch*.

Operating and Checking th Engine:

1. Explain the things which should be installed or adjusted before starting the engine. *(Refer to repair manual for specific procedures.)*

2. Explain how to set the main fuel and idle screw with the engine running. *(Refer to operator's manual for specific engine.)*

Read the following statements on safety and place an "A" by those statements which would be good "approved practices" to observe:

A 1. Storing gasoline in approved metal containers.

A 2. Removing gasoline from the gas tank and carburetor before repairing an engine.

________ 3. Refilling a gasoline tank with the engine running.

A 4. Working in a well-ventilated shop.

A 5. Using an approved solvent for cleaning engine parts.

A 6. Removing the spark plug wire before servicing or repairing an engine.

A 7. Having dry chemical fire extinguishers available.

A 8. Following good work habits.

A 9. Reading and following your operator's and/or service manual.

A 10. Cleaning the engine before it is serviced.

________ 11. Using gasoline for cleaning engine parts.

________ 12. Working on a hot engine.

A 13. Storing greasy shop rags in a metal air-tight container.

A 14. Cleaning wrenches and other tools before storing.

A 15. Securing the engine in an approved mount before starting to work on the engine.

________ 16. Operating the engine with the governor disconnected.

A 17. Operating a vertical shaft engine with a special flywheel when adjusting the governor and carburetor.

________ 18. Test-running the engine without the engine shroud which covers the flywheel.

________ 19. Handling volatile fuels in a shop or area which has an open flame.

A 20. Removing all fuel from an engine before placing it in dry storage.

________ 21. Operating an engine which has gasoline dripping from the fuel system.

________ 22. Operating an engine with the muffler removed.

A 23. Assembling the engine using bolts and cap screws of the specified grade.

A 24. Using a starter rope which is not frayed.

________ 25. Using "ether-type" starter fluids to start small engines.

________ 26. Using a torch to repair leaks in a gasoline tank.

________ 27. Operating a vertical shaft lawn mower with a cracked or bent blade.

________ 28. Spilling gasoline on a hot engine.

A 29. Wearing safety glasses when in the shop.

A 30. Using an approved flywheel holder when removing a flywheel nut.

A 31. Keeping hands and face away from the carburetors when cranking an engine if the air cleaner is removed.

STUDENT WORKSHEET #6

Using Small Engine Measuring Tools

Objectives:

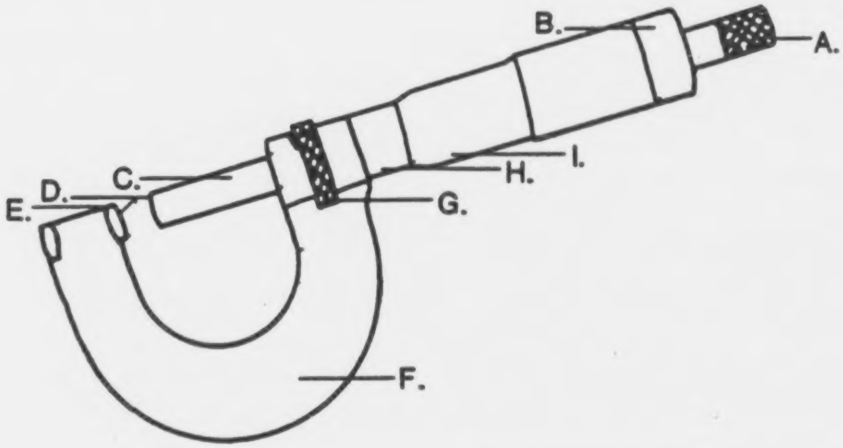
1. To be able to identify the parts of a micrometer.
2. To be able to correctly read a micrometer.
3. To be able to correctly read a flat feeler gauge.

Materials:

1. six-inch micrometer with interchangeable anvils
2. crankshaft
3. valve
4. camshaft
5. assembles small engine
6. VAS Unit #U3023, *Micrometers and Related Measuring Tools*

Procedure:

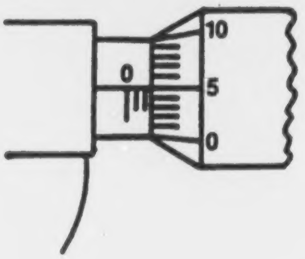
1. Identify the following parts of a micrometer:

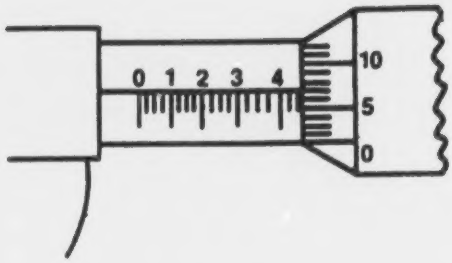


A. ____________________
B. ____________________
C. ____________________
D. ____________________
E. ____________________
F. ____________________
G. ____________________
H. ____________________
I. ____________________

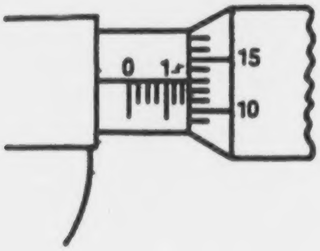
2. Practice reading the micrometer scales by following these steps:
   a. Read the highest figure visible on the barrel.
   b. Add 0.015 inch for each line between the number and the thimble edge.
   c. Add the number of the line on the thimble that coincides with or has passed the reference line.
   d. Add the number of the graduation on the vernier that coincides with a line on the thimble.
   e. Add the above figures for the measurement.

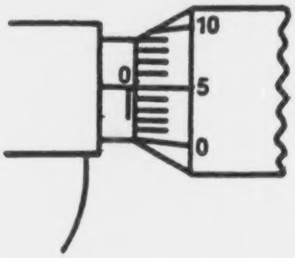
Determine the correct reading for each of the following:





A. ______________________________ B. ______________________________





C. ______________________________ D. ______________________________

3. Using a micrometer measure the following small engine parts. Compare your measurements with the standards listed in the repair manual. Determine if the part can be used or if it should be rejected.

	Measurement	**Recommendation**
a. Crankpin	________________	________________
b. Cylinder wall	________________	________________
c. Flywheel journal	________________	________________
d. PTO journal	________________	________________

4. Using an engine assigned by your instructor, use a feeler gauge to determine the following air gaps. Compare your measurements with the standards listed in your repair manual.

	Measurement	**Recommendation**
a. Spark plug	________________	________________
b. Intake valve	________________	________________
c. Exhaust	________________	________________
d. Armature	________________	________________
e. Ignition points	________________	________________

STUDENT WORKSHEET #7

Four-Cycle and Two-Cycle Engine Specifications

Using the small engines assigned to you by your instructor, complete the following information on a four-cycle and two-cycle engine. (Refer to owner/operator manuals and small engine)

Four-Cycle Engine:

1. Name of motor ____________________
2. Serial number ____________________
3. Model number ____________________
4. Idle R.P.M. ____________________
5. High speed R.P.M. ____________________
6. Crankshaft — vertical or horizontal ____________________
7. Piston — vertical or horizontal ____________________
8. Type of lubrication system ____________________
9. Engine horsepower ____________________
10. Diameter of cylinder ____________________
11. Length of stroke ____________________
12. Spark plug gap ____________________
13. Point gap ____________________
14. Condenser capacity ____________________
15. Flywheel air gap ____________________
16. Type of oil recommended in summer; in winter ____________________
17. Type of carburetor ____________________
18. Type of governor ____________________
19. Type of air cleaner ____________________
20. Type of starting mechanism ____________________

Two-Cycle Engine:

1. Make of engine ____________________
2. Serial number ____________________
3. Model number ____________________
4. Grade of gasoline recommended ____________________
5. Type of oil recommended ____________________
6. Breaker point gap ____________________
7. Type (size of spark plug) ____________________
8. Spark plug gap ____________________
9. Type of carburetor ____________________
10. Type of air cleaner ____________________
11. High speed R.P.M. ____________________
12. Type of choke system ____________________
13. Armature air gap ____________________

STUDENT WORKSHEET #8

Four-Cycle Engine Overhaul

Objectives:

1. To develop the ability to troubleshoot a four-cycle engine.
2. To develop the ability to correctly disassemble, repair, and reassemble a four-cycle engine.

Materials:

1. used four-cycle engine
2. mechanic's tools
3. service and repair manual

Procedure:

Select a suitable work station, a small engine, and the necessary mechanic's tools. Be sure you have financing available to replace necessary parts. Observe all shop safety rules.

Follow All Directions

1. List the following:
   a. Engine manufacturer ______________________________
   b. Serial Number ______________________________
   c. Model Number ______________________________
   d. Type Number ______________________________
2. Do a compression test by giving the flywheel a quick spin. Does the flywheel rebound sharply? ________ What is the actual compression? ________________
3. Check the crankshaft end play. What is the recommended range?
4. What is the condition of the spark plug? __________ Is there spark? ______________________
5. Drain the oil . . . remove the spark plug . . . and muffler.
6. Draw a sketch of the governor linkage in respect to the carburetor and the governor system. (Use reference book if necessary.)
7. Remove the air cleaner . . . carburetor . . . gas tank . . . governor linkage. **Remember the position of these parts!**
8. Remove the engine shroud. Does the starter pull evenly and smoothly? ______________________
9. Remove the crankshaft screen (if any), nut, and starter mechanism. What tools did you use? ______________

10. Using a flat feeler gauge, measure and report the armature air-gap clearance.
    a. Armature air gap found ____________________
    b. Manufacturer's recommendation ____________________

11. Remove the flywheel.

12. What is the condition of the flywheel key? ________________ What is the purpose of having a soft key in the crankshaft groove?

____

____

13. Remove the breaker-point cover. Make a sketch of the ignition system. Include armature and coil unit, breaker points, condenser, spark plug, and all wires. Are the parts and wires installed properly and in good condition? Label all parts of sketch.

14. Check the breaker-point gap with a feeler gauge.
    a. Gap found ____________________
    b. Manufacturer's recommendation ____________________

15. Check the spark plug gap with a feeler gauge.
    a. Gap found ____________________
    b. Manufacturer's recommendation ____________________

16. Remove the cylinder head and head gasket. Draw a picture of the head. Show length of bolts used and locations where bolts are placed.

17. Remove valve cover plate.

18. Measure and report the valve tappet clearance for each valve. (To measure, the valve has to be closed.)

	Actual	Manufacturer's Recommendation
a. Intake		
b. Exhaust		

19. Remove valve springs and valves. Keep the same springs with the same valves. What are the conditions of the valve springs, valves, and valve face and seats?

20. Remove the crankcase cover plate.

21. Note the position of the timing marks on the crankshaft and camshaft gears.

22. Remove the camshaft and tappets.

23. Mark the connecting rod cap and connecting rod. Unbolt the connecting rod cap and use plastigage to measure the clearance.

    a. Actual

    b. Manufacturer's recommendation

24. If needed, use a ridge hammer tool to remove the ridge at the top of the cylinder.

25. Push the piston and rod out the top of the cylinder.

26. Remove the crankshaft. Measure and report the crankpin size.

    a. Actual

    b. What is the reject size?

27. Measure and report the size of crankshaft journals. What are the reject sizes?

    a. Magneto journals

    b. PTO journal

28. How many rings does this engine have? ____________ Name them.

29. **Carefully** remove the top ring from the piston. Place it about one inch down into the cylinder. Measure and report ring gap clearance with a flat feeler gauge. What is the reject measurement? ____________

30. Report the general condition of the piston.

31. Report the general condition of cylinder walls.

32. Report the cylinder bore and stroke, according to specifications.

    a. Bore ______________________________
    b. Stroke ______________________________

33. Determine the engine's displacement in cubic inches.

    $(\text{Bore}^2 + 4) \times 3.14 \times \text{Stroke} =$ ______________________________

34. There are several repairs and jobs that can be done to the engine before reassembly.

    a. Clean the head and cylinder.
    b. Sand the magnet on the flywheel with Emery paper.
    c. Clean and gap the spark plug (unless a new one will be purchased).
    d. Clean all parts and inspect all gaskets
    e. Grind the valve face.
    f. Refinish the valve seats.
    g. Grease the spin wheel on the starter.
    h. Inspect and clean fuel system and air cleaner.
    i. List new parts needed and their cost.

35. Write and sketch the correct *torque* and *sequence* to tighten the head bolts.

36. What is the proper torque on the connecting rod bolts? ____________

    Be sure to use *oil* when putting each part back together.

37. Replace all parts and gaskets which do not meet specifications.

38. Reassemble engine in reverse procedure of disassembly.

39. Start and tune engine.

40. Briefly describe the condition of the engine and any special operating instructions the owner should follow after the engine overhaul.

    ____
    ____
    ____
    ____
    ____

STUDENT WORKSHEET #9

Two-Cycle Engine Overhaul

Objectives:

1. To develop the ability to troubleshoot a two-cycle engine.
2. To develop the ability to correctly disassemble, repair, and reassemble a two-cycle engine.

Materials:

1. used two-cycle engine
2. mechanic's tools
3. service and repair manual

Procedure:

Select a suitable work station, a small engine, and the necessary mechanic's tools. Be sure you have financing available to replace necessary parts. Observe all shop safety rules.

Follow All Directions

1. List the following:
    a. Engine manufacturer ______________________________
    b. Serial Number ______________________________
    c. Model Number ______________________________
    d. Type Number ______________________________
2. Do a compression test by giving the flywheel a quick spin. Does the flywheel rebound sharply? __________ What is the actual compression? ______________________________
3. Check the crankshaft end play. What is the recommended range? ______________________________
4. What is the condition of the spark plug? ________ Is there spark? ______________________________
5. Draw a sketch of the governor linkage in respect to the carburetor and the governor system. (Use reference book if necessary.)

6. Remove the following parts and inspect them for excessive wear. Remember the position of each part. (NOTE: All engines may not require removal of all these parts.)
    a. Air cleaner
    b. Spark plug
    c. Muffler
    d. Carburetor
    e. Gas tank
    f. Governor linkage
    g. Engine shroud
    h. Flywheel screen

7. Using a flat feeler gauge, measure and report the armature air-gap clearance.

    a. Actual ______________________________

    b. Manufacturer's recommendation ______________________________

8. Remove flywheel.

9. What is the condition of the flywheel key? __________ What is the purpose of having a soft key in the crankshaft groove? ______________________________

10. Remove the breaker-point cover.

11. Make a sketch of the ignition system. Include armature and coil unit, breaker points, condenser, spark plug, and wiring. Label all parts of sketch.

12. Inspect all ignition parts for wear.

13. Check the breaker-point gap with a feeler gauge.

    a. Gap found ______________________________

    b. Manufacturer's recommendation ______________________________

14. Check the spark plug gap with a feeler gauge.

    a. Gap found ______________________________

    b. Manufacturer's recommendation ______________________________

15. Briefly describe the general condition of the ignition system.

    ____

    ____

16. Remove the cylinder head and head gasket.

17. Draw a picture of the head. Show length of bolts used and locations where bolts are placed.

18. Briefly describe the condition of the cylinder head area and gasket. Is there evidence of compression leakage?

19. Inspect the reed plate, crankcase gaskets, and main bearing seals for pressure leakage.

20. Remove crankcase cover plate.

21. Mark the connecting rod cap and connecting rod. Unbolt the connecting rod cap and use plastigage to measure the clearance.
    a. Gap found ____________________
    b. Manufacturer's recommendation ____________________

22. If needed, use a ridge reamer tool to remove the ridge at the top of the cylinder.

23. Remove piston and connecting rod.

24. Remove the crankshaft. Measure and report the crankpin size.
    a. Gap found ____________________
    b. Manufacturer's recommendation ____________________

25. Measure and report the size of crankshaft journals.
    a. Magneto journal ____________________
    b. PTO journal ____________________

26. What are the manufacturer's reject sizes of the crankshaft journals?
    a. Magneto journals ____________________
    b. PTO journals ____________________

27. How many rings does this engine have? __________ Name them. ____________________

28. **Carefully** remove the top ring from the piston. Place it about one inch down into the cylinder. Use piston to square the ring in the cylinder. Measure the ring gap end clearance with a flat feeler gauge.
    a. Gap found ____________________
    b. Manufacturer's recommendation ____________________

29. Use an inch micrometer or telescoping gauge to measure cylinder taper.
    a. One inch from top ____________________
    b. One inch from bottom ____________________

30. Inspect and report general condition of the piston.

31. Inspect and report the general condition of the cylinder wall.

    a. Condition ____________________

    b. Diameter ____________________

    c. Out-of-roundness ____________________

32. Report the cylinder core and stroke. Use manual to locate specifications.

    a. Bore ____________________

    b. Stroke ____________________

33. Determine the engine's displacement in cubic inches.

    $(\text{Bore}^2 + 4) \times 3.14 \times \text{Stroke} =$ ____________________

34. There are several repairs and jobs that can be done to the engine before reassembly.

    a. Clean the head and cylinder.
    b. Sand the magnet on the flywheel with Emery paper.
    c. Clean and gap the spark plug (unless a new one will be purchased).
    d. Clean all parts and inspect all gaskets.
    e. Grind the valve face.
    f. Refinish the valve seats.
    g. Grease the spin wheel on the starter.
    h. Inspect and clean fuel system and air cleaner.
    i. List new parts needed and their cost.

35. Write and sketch the correct *torque* and *sequence* to tighten the head bolts.

36. What is the proper torque on the connecting rod bolts? ____________________

    Be sure to use *oil* when putting each part back together.

37. Replace all parts and gaskets which do not meet specifications.

38. Reassemble engine in reverse procedure of disassembly.

39. Start and tune engine.

40. Briefly describe the condition of the engine and any special operating instructions the owner should follow after the engine overhaul.

    ____

    ____

    ____

STUDENT WORKSHEET #10

Preparing Small Engines for End of Season Storage

Objective:

1. To be able to properly prepare small engines for off-season storage.

Materials:

1. mechanic's tools (socket set, wrenches, screwdrivers)
2. oil squirt can
3. catch pan for used oil
4. clean shop rags
5. pressurized air

Procedure:

1. Drain fuel tank and start engine to remove excess fuel from carburetor system.

2. If engine is to be stored in a damp, cold location, close the valve on the fuel line (if one is used) and refill the tank with fuel. This will prevent the tank from rusting. This fuel should be discarded before starting the engine at the beginning of the next season.

3. Clean the engine to remove all dirt and oil on the outside of the engine and under the shroud.

4. Remove the spark plug and squirt about 1/2 to 1 teaspoon of oil into the cylinder. Rotate the crankshaft three or four times to coat the cylinder with oil. Replace the spark plug.

5. Drain and refill engine crankcase on four-cycle motor.

6. Service and clean air filter.

7. Apply paint, oil, or grease to exposed unpainted surfaces to prevent rusting.

8. Cover engine with plastic and store inside building where it is not in contact with the ground.

9. Complete the information and check the service jobs performed.

Mower Information

Name of Owner ______________________ Address ______________________

Make of Mower ______________________ Date of Service ______________________

Engine Make ______________________ Serial Number ______________________

Model ______________________ Type ______________________

Service Report

______ 1. Clean engine and mower thoroughly.

______ 2. Check ignition system.

a. Test spark plug intensity.

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  - b. Clean and regap plugs.
  - c. Inspect and gap points.
  - d. Check ignition wires.
  - e. Check flywheel shear key.

_____ 3. Check compression.

_____ 4. Service air cleaner.

_____ 5. Drain sediment bowl, carburetor, and fuel tank.

_____ 6. Drain and change crankcase oil (4-cycle engine).

_____ 7. Clean exhaust ports (2-cycle engine).

_____ 8. Protect cylinder with teaspoon of clean oil poured in spark plug hole.

_____ 9. Check for general condition — loose nuts or screws, leaks, cracked or broken parts and repair if necessary.

_____ 10. Sharpen blade (rotary mower).

_____ 11. Report need for repair or replacement parts.

_____ 12. Check and clean undercarriage of mower.

Questions:

1. What type and weight of oil should be used with small engines for:
   - a. Summer use? _____
   - b. Winter use? _____
2. How often should oil be changed in four-cycle engines?
   _____
   _____
3. If an engine will not start how would you proceed to determine the cause?
   _____
   _____

Observations:

How can these skills be used to improve your SAEP?

_____

_____

_____

_____

_____

STUDENT WORKSHEET #11

Friction and Lubricant Laboratory

Discussion:

When two surfaces move against each other friction is present. Friction can be bad if it creates excess heat or causes wear. If used properly, friction can be good. This lab explains what happens when lubricants are used to reduce or overcome friction.

What Causes Friction?

There are three principle causes of friction in solids. They are:

1. Surface friction — The finish (or degree of smoothness) of a material is a major factor related to friction. Surface irregularities cause a grinding action as the surfaces move against each other. As a result, heat is generated and particles are worn away from the materials.

2. Cohesion and adhesion of molecules — Cohesion results when two surfaces of the **SAME** material are in contact. The molecules of one surface have an attraction for molecules of the other surface. For example, when two glass surfaces are placed together and all the air is removed from between them, they become "fastened" together. They're extremely hard to pull or slide apart. On the other hand, adhesion is the tendency for molecular attraction between unlike molecules. Adhesive tape and glue are examples of materials with adhesive properties.

3. Weight or force holding the surfaces together — It is more difficult to drag a 200-lb bag of sand than a 100-lb bag of sand across a floor. That's because the 200-lb bag "presses" onto the floor with a force that is twice as large as that for the 100-lb bag. The frictional force between moving surfaces is stated in the equation:

What's a Lubricant?

Moving parts are lubricated to reduce friction, wear, and heat. (See figure below.) Lubricants are designed for different purposes. But all lubricants must meet three conditions:

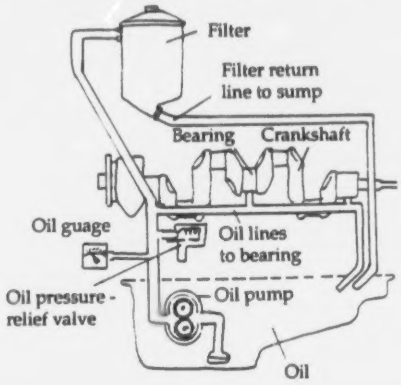
1. The lubricant must be able to withstand the heat produced during operation.

2. The lubricant must flow freely and maintain a thin film between moving parts.

3. The lubricant should prevent corrosion or rust.

The first job of a lubricant is to form a liquid layer that separates the surfaces of moving parts. This cuts down on friction and surface wear. Just as soap cleans a dirty face, detergents are added to oil to clean surface areas of tar and shellac caused by the heat buildup in the oil. Tar and shellac are then separated from the oil by an oil filter. Layers of oil moving across each other generate less friction than metal or similar surfaces do. So separation of surfaces reduces both heat generated and surface wear.

In the following heat lab, you'll observe the effects of lubrication on two materials that are in contact.



$$\mu = f + N$$

Where:

μ = a numerical constant, called the "coefficient of sliding friction" for two surface (different constant for different surfaces)

f = frictional force

N = Normal force pressing surfaces together

The larger the normal force, the larger the force required to move the object.

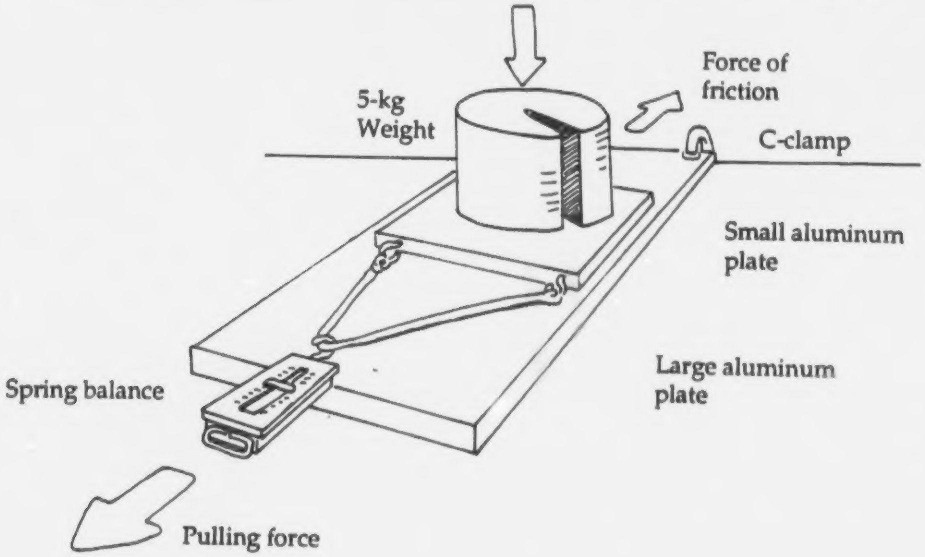
Materials:

1. large, flat aluminum plate, 6" x 18" x 1/4"
2. small, flat aluminum plate, 4" x 6" x 1/4"
3. C-clamps, two
4. spring balance, 0 to 25 lbs (0 to 111N)
5. large slotted weight set
6. triple-beam balance
7. oil, 3-oz multigrade motor oil
8. disposable rags or paper towels for oil cleanup

Procedure:

Follow the procedure outlined below. You should be able to determine how the frictional force is affected by surface texture (smooth or rough), normal force, and lubrication.

1. Study the setup of the apparatus shown in the figure below.
2. Weigh the small aluminum plate. Record this value here. W_p = __________ .
3. Place the small aluminum plate with the *rough side down* at one end of the large aluminum plate. Place a five-kg weight on the small plate.
4. Connect the spring balance to the small aluminum plate, as shown in the figure.
5. Begin to pull on the spring balance. Increase the pulling force slowly until the plate begins to move. Then adjust the pulling force (F) so that the small aluminum plate with the 5-kg weight moves at a constant speed.
6. Repeat step 5 until you are sure that you can get the aluminum plate to move at a constant speed. Record the value of F as indicated by the spring balance as F_{5A} in the Data Table.
7. Add a 2-kg weight to the 5-kg weight on the small plate, for a total of 7-kg weight. Repeat steps 5 and 6 above. Record the value of F as F_{7A} in the Data Table.
8. Add a 1-kg weight to the 2-kg and 5-kg weights on the small plate for a total of 8-kg weight. Repeat steps 5 and 6 above. Record the value of F as F_{8A} in the Data Table.
9. Remove the weights. Then turn the small aluminum plate over. This places the *smooth surface down* in contact with the large plate.
10. Repeat steps 4 through 8 recording the respective values of F as F_{5B}, F_{7B}, and F_{8B} in the appropriate blocks of the Data Table. These values will be recorded in row B.
11. Remove the weights from the small aluminum plate. Pour a small amount of oil (5 or 6 drops) on the surface of the large plate. Use just enough to form a thin layer over the plate. Distribute the oil evenly by moving the small plate over the larger plate. Position the small plate at one end of the large plate.
12. Repeat steps 4 through 8. Record the respective values of F as F_{5C}, F_{7C}, and F_{8C} in the correct blocks of the Data Table. These values will be recorded in row C.



Data Table - Force (F) Needed to Move Plate

		F_5 $W_p + 5$ kg	F_7 $W_p + 5$ kg + 2 kg	F_8 $W_p + 5$ kg + 2 kg + 1 kg
ROW A	Rough Surface Without Lubrication	$F_{5A}=$	$F_{7A}=$	$F_{8A}=$
ROW B	Smooth Surface Without Lubrication	$F_{5B}=$	$F_{7B}=$	$F_{8B}=$
ROW C	Smooth Surface With Lubrication	$F_{5C}=$	$F_{7C}=$	$F_{8C}=$

Calculations:

Calculate the coefficient of sliding friction. Use the equation:

$$\mu = f \div N$$

Where: μ = coefficient of sliding friction
f = frictional force = pulling force (F)
N = normal force = weight

Remember: f = F when the speed between the two surfaces is constant.

1. **NOTE:** Since the small aluminum plate is on a HORIZONTAL surface, the normal force (N) is equal to the total weight of the small aluminum plate (W_p) and added weights. Weight of the small plate (W_p) was recorded in procedure step 2.

Thus, the first step in finding μ is to find N.

$N_5 = W_p + (5\text{ kg})$ wt = ____________
$N_7 = W_p + (5\text{ kg}) + (2\text{ kg})$ wt = ____________
$N_8 = W_p + (5\text{ kg}) + (2\text{ kg}) + (1\text{ kg})$ wt = ____________

Be sure to use proper units. If working in SI, use newtons for weight. If working in English units, use pounds for weight.

Before continuing with step 2, be sure you understand that $f_{5A} = F_{5A}$, and so on. Thus, the values for the force in the Data Table provide the value of the frictional force (f), as well as the value of the pulling force (F).

2. Using the values of N in step 1 above, find the μ for each condition and normal force. Remember that f = F when speed is constant.

   a. Find μ for a rough surface without lubrication (Row A of the Data Table).

$\mu = f_{5A} \div N_5 =$ ____________
$\mu = f_{7A} \div N_7 =$ ____________
$\mu = f_{8A} \div N_8 =$ ____________

   b. Find μ for a smooth surface without lubrication (Row B of the Data Table).

$\mu = f_{5B} \div N_5 =$ ____________
$\mu = f_{7B} \div N_7 =$ ____________
$\mu = f_{8B} \div N_8 =$ ____________

   c. Find μ for a smooth surface with lubrication (Row C of the Data Table).

$\mu = f_{5C} \div N_5 =$ ____________
$\mu = f_{7C} \div N_7 =$ ____________
$\mu = f_{8C} \div N_8 =$ ____________

Questions:

1. Is the μ calculated for each of the surfaces the same? Or does it change with different surface conditions?
2. What effect does lubrication have on μ? How is this effect produced?
3. For any given surface, does changing the weight bearing down on the plate significantly change μ?

STUDENT WORKSHEET #11 — Key

Friction and Lubricant Laboratory

Note:

You should go through this lab, perform the measurements, and complete the Data Table prior to student participation. Check out any difficult areas that may require emphasis when briefing students before they do the lab.

A critical factor in this lab is to ensure that the pulling force (F) is equal to the frictional force (f). This can be accomplished if the top plate moves at a constant speed. Encourage your students to take their time when determining constant speed by repeating step 5 several times.

This experiment may not require the full time allocated. If time allows, students can substitute a dry lubricant (such as graphite) and repeat that part of the experiment. This will allow them to compare oil and dry lubricants. Remind your students that both oil and graphite are carbon-based lubricants.

Note:

The small aluminum plate must have each edge and corner deburred and rounded. Sharp edges or burrs can gouge the large plate and will give inconsistent results. Use a file to remove any burrs or sharp edges.

Notes on Procedure Step 5:

Constant speed is crucial. It is difficult — but possible — to achieve in the space provided (18 inches). Emphasize that more consistent and reliable data will be obtained by moving the weight at a constant speed.

Notes on Subscripts F_{5A}, F_{7B}, etc.

Students are often confused and uncertain about a letter or symbol that has a subscript. Usually, this is due to their unfamiliarity with the notation. Spend a few moments explaining that the subscripts presented here are similar to those used in technology. They are a type of "short-hand" symbol for long titles or descriptions. For example, F_5 in this lab means "the force needed to pull the aluminum plate with the 5-kg weight on it in Trial A." Trial A involves the rough-surface side of the aluminum plate moving down across the large aluminum plate.

Note on Procedure Step 11

Only a few drops of oil are needed. Do not flood the plate with oil.

Notes on Calculations

Forces are *vector quantities* and, therefore, are correctly described only when *both* magnitude and direction are specified. In this lab, we are concerned with two pairs of forces.

1. Weight and the normal force are one pair. Their magnitudes are always equal when acting in the vertical plane. However, their directions are opposite. Thus, we should say $N = -W$. The statements in the student text consider just the magnitudes.
2. The pulling force and the frictional force are the other pair. Here the magnitudes are equal. And, once again, their directions are opposite as long as the rate of motion is constant. Thus, we should say $f = -F$. However, to help avoid confusing your students, we will consider magnitudes only.

Note:

Emphasize to students that when there is no acceleration, we know that there are no net forces. This means that all forces are in balance. For two forces acting along a line, balance means that the two magnitudes are equal, but the directions of application are opposite.

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STUDENT WORKSHEET #12

Gas Physics — Demonstration

Purpose:

1. To demonstrate the relationship between the volume of a gas and its temperature and pressure. These relationships have applications in understanding the operation of internal combustion engines.

Materials:

1. a plastic syringe (25 ml or larger)
2. ring stand and clamp or a 2 x 4 with a hole to fit the syringe
3. heat gun or hair dryer
4. portable bunsen burner

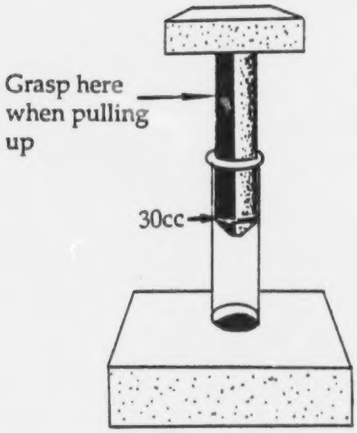
Procedure:

1. Prepare a syringe cap by heating the needle cap with a match or candle flame until the needle can be pulled out with pliers. Discard the needle. Continue to heat the cap until the plastic seals itself shut. The sealed cap is now an effective gas-tight seal for the syringe.

2. To qualitatively demonstrate the **effect of pressure on volume of a gas (Boyle's Law)**, set the plunger of the syringe to a convenient mark near the top of the syringe. Place the sealed cap tightly on the tip of the syringe. Try pushing in and pulling back on the plunger. What happens to the column of gas inside the syringe when you increase the pressure on the plunger? What happens when you decrease the pressure by pulling out the plunger?

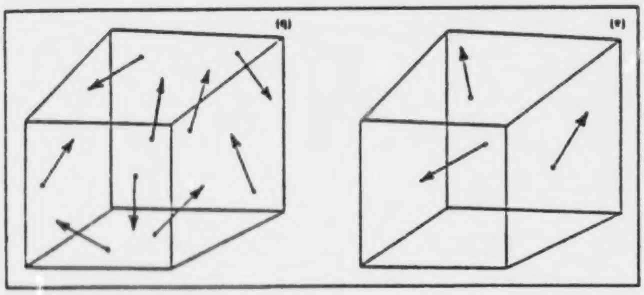
3. To quantitatively demonstrate Boyle's Law, clamp the syringe to the ring stand or place it in the hole in the 2 x 4. Books of the same size or weights can be placed on the plunger and the volume recorded. Make a chart of weight added versus volume and plot a graph of your results.

4. To demonstrate the **effect of temperature on the volume of a gas (Charles' Law)**, set the plunger of the syringe about halfway up the barrel. Record the volume and heat the bottle with a heat gun or hair dryer. What happens to the volume of gas? Try placing the syringe in a container of ice. What happens to the volume?



Discussion:

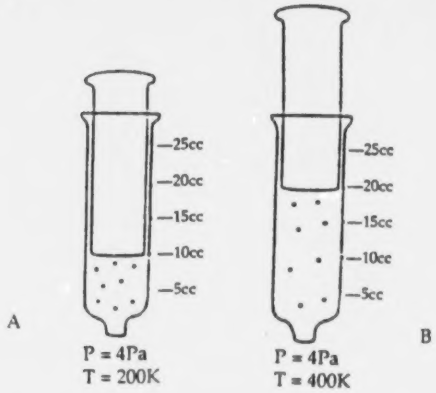
The behavior of gases is easily described on the molecular level. Gases are composed of molecules or atoms that are very far apart and are in constant, random motion. Gases exert a pressure when the molecules collide with the walls of the container. The average speed of the gas molecules is measured by the temperature. As the temperature of the gas increases, the gas molecules move faster and faster; when the temperature is lowered, they slow down.

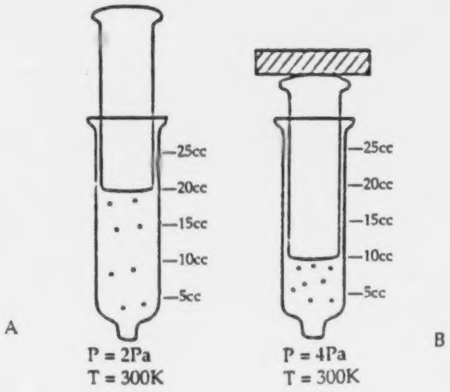


Gases exert pressure when the molecules collide with the walls of the container. (a) Few molecules produce little pressure. (b) Many molecules produce high pressure.

In the Boyle's Law demonstration, when the volume of gas is decreased, the molecules of gas strike the wall of the container more frequently, and the pressure increases. The volume of gas is inversely proportional to the pressure applied to the gas.

When the gas is heated, the molecules move faster and strike the sides of the container more frequently causing the pressure to increase. If the gas is confined, like in an aerosol can placed in a fire, the pressure increases enough to rupture the can. In the syringe, the plunger inside the syringe is equal to the pressure applied to the plunger.





Questions:

1. What implications does this scientific principle have for agriculture?
2. Give examples of agricultural occupations in which this principle is used.

STUDENT WORKSHEET #13

Effect of Pressure on the Boiling Point of a Liquid — Demonstration

Objective:

1. To demonstrate that the boiling point of a liquid is lowered when the pressure is reduced. This has applications for understanding carburetors in gasoline engines.

Materials:

1. one plastic syringe with cap
2. hot water
3. denatured alcohol (boils at room temperature if pressure is decreased)

Procedure:

1. Draw some of the hot water into the syringe. Cap the syringe with an airtight cap. Pull back the plunger and observe the water.

2. Repeat this experiment using room temperature alcohol.

Discussion:

All liquids have some vapor above the surface of the liquid, and this vapor exerts a vapor pressure. The boiling point of a liquid is the temperature at which its vapor pressure is equal to its external pressure. When the external pressure above a liquid is reduced, the boiling point of a liquid decreases. This is why water boils at a lower temperature at high altitudes. Also, when a piston in the cylinder of an engine pulls back on the intake stroke, the pressure is lower in the chamber causing some of the volatile gasoline to fill the cylinder.

Reference:

From a presentation by Dr. Gary Trammell at the Agricultural Education Workshop, University of Illinois, Urbana, IL 61801 on October 7, 1988.

STUDENT WORKSHEET #14

Alcohol Vapor Explosion — Demonstration

Objective:

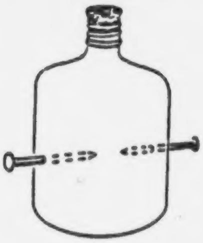
1. To demonstrate the combustion of vapors of a flammable liquid in air. This simulates the combustion process inside a gasoline engine.

Materials:

1. two to three ml of 95% ethanol
2. two nails
3. 250-ml polyethylene bottle
4. cork to fit bottle
5. Tesla coil (supplied by physics teacher; or from Sargent-Welch, catalog number S-30978, $95.40)

Procedure:

1. Insert one of the nails through the side of the bottle about halfway up. Insert the other nail through the opposite side. Position the tips of the mails so there is a gap of about 1/4 inch (0.5 cm) near the center of the bottle. Pour 2 - 3 ml (a layer about 1/8 inch deep) of 95% alcohol in the bottle and stopper with the cork. Set the bottle in an area free of overhead obstructions.



2. Turn on the Telsa coil and bring its tip to one of the nails. A spark will jump to the nail and from one nail to the other. This spark inside the bottle detonates the mixture of alcohol vapor and air, causing the cork to shoot out of the bottle.

3. This demonstration cannot be repeated without flushing the bottle with air. This is because the explosion consumes all the oxygen in the bottle, replacing it with carbon dioxide.

Discussion:

A small amount of the ethanol liquid in the bottle vaporizes, and the vapor produces an explosive mixture with oxygen in the air. When a spark is created between the electrodes, the mixture detonates, forcing the stopper from the bottle.

This discussion emphasizes the fire triangle for fire prevention. Fire requires fuel, oxygen, and heat. Without all three of these elements, no fire will occur. The vapor and oxygen mixes until heat, in the form of a spark, is present. This presence causes the explosion. The same process occurs in the cylinder of a gasoline engine.

$$C_2H_5OH + 3\,O_2 \rightarrow 2\,CO_2 + 3\,H_2O$$

Reference:

Chemical Demonstrations: A Handbook for Teachers of Chemistry, vol 2, Bassam Z. Shakhashiri, ed., (Madison: University of Wisconsin Press, 1985), 216-219.

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agricultural Engineering/Mechanization

PROBLEM AREA: Financing and Managing Agricultural Equipment

RELATED PROBLEM AREAS:

1. Applying Mathematics Skills in Agriculture (Central Core Cluster)
2. Developing Problem Solving Skills in Agriculture (Central Core Cluster)
3. Keeping and Using Records in Agricultural Operations (Central Core Cluster)
4. Financing the Agribusiness
5. Repairing and Maintaining Agricultural Equipment

PREREQUISITE PROBLEM AREA(S):

1. Applying Mathematics Skills in Agriculture (Central Core Cluster)

LEVEL: Preparatory

OCCUPATIONAL TASKS ADDRESSED:

Duty F: Financing the Agribusiness

1. Prepare depreciation schedule
2. Calculate net worth of machinery
3. Calculate operating expenses

Duty H: Managing the Business

1. Maintain equipment records
2. Select computer software for machinery management decisions

STATE GOALS FOR LEARNING

In planning the instruction for this problem area, teachers can promote the development of several student learning objectives which are related to the State Goals for Learning in Mathematics. These objectives are listed on the Learning Assessment Plan forms included on the following page(s). Those learning objectives marked with an asterisk (*) are taken from the sample lists provided by the Illinois State Board of Education.

CORE

Illinois Agricultural Core Curriculum

Agricultural Education 124 Mumford Hall 1301 W. Gregory Drive University of Illinois Urbana, IL 61801

Director: Dale A. Law, Ed.D.
Principal Investigator: Jerry D. Pepple, Ed.D.
Research Assistant: Douglas L. Stockley

88/89
Agricultural Business and Management
Agricultural Engineering/Mechanization

1687

Illinois Agricultural Core Curriculum Rev.

Submission Date ________________

☐ Original submission ☐ Revision

Page ____ of ____

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)

COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐

District Name

City

I. LEARNING AREA *(check one)*

☐ Language Arts
☒ Mathematics
☐ Sciences
☐ Fine Arts
☐ Social Sciences
☐ Physical Development/Health

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to use mathematics to estimate, approximate, and predict outcomes and to judge reasonableness of results.

Contact Person: ________________
Title: ________________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Identify effects of a poor estimate.					
*2. Know whether enough information is presented to arrive at a conclusion.					
*3. Identify information that is irrelevant to a given question.					
*4. Identify information that was used in arriving at a particular conclusion.					
*5. Apply problem-solving procedures to solve or suggest a solution to a given problem.					
1688					1689

ISBE 41-78 (1/88)

Agricultural Business and Management
Agricultural Engineering/Mechanization

Financing and Managing Agricultural Equipment

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

Submission Date ____________
☐ Original submission ☐ Revision
Page ____ of ____

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☒ Mathematics ☐ Social Sciences
☐ Sciences ☐ Physical Development/Health

(Affix label or complete district information.)
COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐
District Name
City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to understand and use methods of data collection and analysis, including tables, charts, and comparisons.

Contact Person: ____________
Title: ____________
Phone: ( )

III. LEARNING OBJECTIVES

By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:

III. LEARNING OBJECTIVES	IV. ASSESSMENT A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	V. EXPECTATIONS Percent of Students Expected to Achieve Objective
1. Analyze tables, charts, arrays, schedules, experiments, and surveys reported in media sources.					
2. Understand information management.					
3. Design and conduct a simulation to gain information about a problem.					
1690					
					1691

ISBE 41-78 (1/88)

Illinois Agricultural Core Curriculum Rev.

Submission Date ____________
☐ Original submission ☐ Revision
Page ____ of ____

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☒ Mathematics ☐ Social Sciences
☐ Sciences ☐ Physical Development/Health

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)

COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐

District Name

City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to identify, analyze, and solve problems using algebraic equations, inequalities, functions, and their graphs.

Contact Person: ____________
Title: ____________
Phone: ( )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Know equivalent forms of a formula.					
*2. Judge the appropriateness of particular values for a variable in a formula.					
1692					1693

ISBE 41-78 (1/88)

Agricultural Business and Management
Agricultural Engineering/Mechanization

Financing and Managing Agricultural Equipment

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

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Submission Date ____________
☐ Original submission ☐ Revision
Page ____ of ____

(Affix label or complete district information.)
COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐
District Name
City

Contact Person: ____________
Title: ____________
Phone: ( )

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☒ Mathematics ☐ Social Sciences
☐ Sciences ☐ Physical Development/Health

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to make and use measurements, including those of area and volume.

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Perform operations with measures.					
2. Apply given formulas to find speed, capacity, and efficiency.					
1694					1695

ISBE 41-78 (1/88)

Illinois Agricultural Core Curriculum Rev.

Submission Date __________

☐ Original submission ☐ Revision

Page ____ of ____

I. LEARNING AREA *(check one)*

☐ Language Arts
☒ Mathematics
☐ Sciences
☐ Fine Arts
☐ Social Sciences
☐ Physical Development/Health

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

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(Affix label or complete district information.)

COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐

District Name

City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to understand and use ratios and percentages.

Contact Person: __________
Title: __________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Solve problems involving percent of increase, percent of decrease, mark-up, and inflation.					
*2. Apply rates and percents in real life situations.					

ISBE 41-78 (1/88)

Financing and Managing Agricultural Equipment

Agricultural Business and Management
Agricultural Engineering/Mechanization

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

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☐ Original submission ☐ Revision
Page _____ of _____

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☒ Mathematics ☐ Social Sciences
☐ Sciences ☐ Physical Development/Health

(Affix label or complete district information.)

COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐

District Name

City

Contact Person: ____________
Title: ____________
Phone: ( )

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to perform the computations of addition, subtraction, multiplication, and division using whole numbers, integers, fractions, and decimals.

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Translate word problem situations to mathematical expressions or sentences.					
*2. Solve word problem situations that have been translated into mathematical sentences.					
*3. Use computational and problem-solving skills in real life situations with or without a calculator as appropriate.					

1698

1699

ISBE 41-78 (1/88)

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agricultural Engineering/Mechanization

PROBLEM AREA: Financing and Managing Agricultural Equipment

STUDENT LEARNING OBJECTIVES

Upon completion of their study of this problem area, students will be able to:

1. Calculate the capacity of agricultural equipment.
2. Calculate the speed of travel of agricultural equipment.
3. Calculate the efficiency of machinery operations.
4. Calculate the power requirements for various field operations.
5. Calculate the size of equipment required to perform field operations in a timely manner.
6. Estimate the fixed costs of owning agricultural equipment.
7. Estimate the variable costs of operating agricultural equipment.
8. Estimate the total costs of owning and operating agricultural equipment.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agricultural Engineering/Mechanization

PROBLEM AREA: Financing and Managing Agricultural Equipment

PROBLEMS AND QUESTIONS FOR STUDY

1. How do you calculate the actual speed of forward travel?
2. What are the different measures of capacity of agricultural equipment?
3. How does actual capacity differ from theoretical capacity?
4. How do you calculate field efficiency?
5. What is horsepower?
6. What are the different ways horsepower is measured?
7. What is implement draft, and how does it effect the horsepower requirement?
8. How can you determine the size of an implement required to match the power of a tractor, or vice versa?
9. Given a field operation that needs to be accomplished in a timely manner, how do you calculate the size of implement and/or the power required?
10. What are the different costs that comprise total fixed costs?
11. What are the different ways to calculate depreciation of machinery?
12. What are the different costs that comprise total variable costs?
13. How do you estimate total fuel consumption and costs for agricultural equipment?
14. How do you estimate lubrication costs for agricultural equipment?
15. How do you estimate repair costs of agricultural equipment?
16. How do you estimate the total cost of owning and operating agricultural equipment?
17. What records need to be kept in order to accurately calculate the cost of owning and operating agricultural equipment?

INSTRUCTOR'S NOTES AND REFERENCES

1701

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agricultural Engineering/Mechanization

PROBLEM AREA: Financing and Managing Agricultural Equipment

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES

1. To calculate the speed of forward travel, have students measure a distance with a tape or some other accurate measuring device. Using a tractor with or without an implement, determine the time required to travel the measured distance. Compare the calculated mph with the mph indicator on the tractor. If they differ, discuss the reasons why they are not the same. (The effect of traction or slippage on forward speed may also be discussed.)

2. Visit a farm and determine widths of various field equipment, horsepower of tractors, preferred operating speeds for different field operations, and any other information necessary for calculating capacities. Ask the farm operator to record the time and work accomplished during field operations. Using the measurements and figures that you have gathered, calculate efficiency. Compare the calculated figures with typical figures for similar field operations. Discuss the results. (If the FFA chapter farms or has plots, this activity could be accomplished with the equipment used on these plots.)

3. Using a PTO Dynamometer, demonstrate to the class how to measure PTO horsepower. Compare the measured horsepower to actual horsepower. (If a PTO dynamometer is unavailable, arrangements can be made with a local implement dealer for a demonstration.)

4. Discuss where tractor performance information such as horsepower, fuel consumption, and operating speeds may be obtained. Review *Nebraska Tractor Test Data* with the class and discuss how the figures contained in these reports may be used in machinery management decisions.

5. Invite a machinery salesperson to class to explain how he or she determines the proper size of tractors and machinery for each customer.

6. Have students determine the new and used value for a specific piece of equipment, as well as other fixed and variable costs. They should be able to support their figures and their findings. This could be a class, small group, or individual project.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agricultural Engineering/Mechanization

PROBLEM AREA: Financing and Managing Agricultural Equipment

REFERENCES

*1. *Machinery Management — Farm Business Management (FBM)*. (Instructor's Guide, Workbook, and Slide Set are also available.). Deere and Company, Dept. 150, 1400 13th, East Moline, IL 61244. (309) 765-2967.

2. *Engineering Applications in Agriculture.* Bowers, Jones, Olver. Stipes Publishing Company, 10-12 Chester Street, Champaign, IL 61820.

3. *Guide for Adjusting Custom Rates and Machine Rental Rates; Management Economic Principles.* (Computer Software); *Types and Calculating Depreciation.* (Computer Software). Hobar Publications, 1234 Tiller Lane, St. Paul, MN 55112. (612) 542-2586

4. *Agri/Com II.* (Computer Software, includes Scheduler, Alternative Crop, Motor Costs, Stream, Depreciation). PhotoCom Productions, P.O. Box 3135, Prismo Beach, CA.

5. *Fitting Machinery and Equipment to the Farm* (VAS Unit #U2039A). Vocational Agriculture Service, College of Agriculture, University of Illinois, 1401 S. Maryland Drive, Urbana, IL 61801. (217) 333-3871.

*Indicates highly recommended reference

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTIONAL RESOURCES

These resources are intended for use by teachers in planning and teaching the materials for this problem area and may be adapted to fit the teaching method(s) used.

INFORMATION SHEET #1 — Calculating Speed, Miles Per Hour

INFORMATION SHEET #2 — Calculating Acres Per Hour

INFORMATION SHEET #3 — Calculating Field Efficiency

INFORMATION SHEET #4 — Calculating Drawbar Horsepower

INFORMATION SHEET #5 — Selecting Equipment

INFORMATION SHEET #6 — What Size Machinery for Your Farm?

INFORMATION SHEET #7 — Fixed Cost Estimates

INFORMATION SHEET #8 — Straight Line Depreciation

INFORMATION SHEET #9 — Sum-of-the-Digits Depreciation

INFORMATION SHEET #10 — Declining Balance Depreciation

INFORMATION SHEET #11 — Variable Cost Estimates

INFORMATION SHEET #12 — Tractor Maintenance and Usage Record

INFORMATION SHEET #13 — Equipment Maintenance and Usage Record

INFORMATION SHEET #14 — Cost of Using Machinery

INFORMATION SHEET #15 — Figuring Custom Rates and Machine Rental Rates

INFORMATION SHEET #16 — Various Formulas for Machinery Management

INFORMATION SHEET #1

Calculating Speed, Miles Per Hour

Factors:

Distance in feet
Time in minutes
Constant = 88

Formula:

Speed (mph) = distance (feet) ÷ [time (minutes) x 88]

Example:

A tractor pulling a sprayer travels 250 feet in 25 seconds. What is the speed of the tractor in miles per hour?

250 feet ÷ [(25 seconds ÷ 60 seconds / minute) x 88] = 250 ÷ (0.417 x 88) = 6.8 mph

INFORMATION SHEET #2

Calculating Acres Per Hour

Factors:

Width in feet
Speed in miles per hour
Efficiency indicated by percent in decimal form
Constant 8.25

Formula:

Acres per hour = (speed x width x efficiency) ÷ 8.25

Example:

A combine with a corn head for six 30-inch rows has an operating speed of 4.4 miles per hour and an efficiency of 70 percent. How many acres per hour can it cover?

(4.4 mph x 15 feet x .70 eff) ÷ 8.25 = 5.6 acres per hour.

NOTE: Given any three of the variables, you should be able to figure out the fourth.

Sample Problems:

Machine	Width (feet)	Speed (mph)	Effective Efficiency (percent)	capacity (acres per hour)
Plow 6 16-in rows	8	4.5	0.85	3.7
Field Cultivator	29	6.05	0.80	17.0
Planter 12 30-in rows	30	6.5	0.6189	14.2
Sprayer	40	9.0	0.55	24.0
Combine 6 30-in rows	10 - 36	7.49 - 2.08	0.60	5.45

INFORMATION SHEET #3

Calculating Field Efficiency

Factors:

Actual time required to cover area
Theoretical time required to cover area

Formulas:

Acres per hour = (speed x width x efficiency) ÷ 8.25 (from Information Sheet #2)
Theoretical time = total acres ÷ acres per hour
Field efficiency = theoretical time ÷ actual time

Example:

An 80-acre field needs to be tilled with a field cultivator. The width of the field cultivator is 30 feet and the operating speed will average 6.3 miles per hour. It takes 4.1 hours to field cultivate this field. What is the field efficiency?

(30 feet x 6.3 mph) ÷ 8.25 = 22.9 acres per hour

80 ÷ 22.9 = 3.49 hours (theoretical time to cultivate field)

3.49 ÷ 4.1 = .85 percent or .85 x 100 = 85% field efficiency

INFORMATION SHEET #4

Calculating Drawbar Horsepower

Factors:

Pounds of draft per foot of width
Speed in miles per hour
Constant = 375

Formula:

Drawbar HP = [Draft (pounds) x Speed (mph)] ÷ 375

Example:

You have a 16-foot chisel plow with a draft of 700 pounds per foot of width. You would like to operate at 5 miles per hour. What is the calculated drawbar horsepower requirement for pulling this chisel plow?

[(700 pounds x 16 feet) x 5 mph] ÷ 375 = 149 Drawbar HP

NOTE: Given draft and drawbar horsepower, you should be able to calculate speed. Given draft per foot of width, speed in miles per hour, and drawbar horsepower, you should be able to calculate machine width.

Table 1. Soil Conditions — Power

Condition of soil	Usable drawbar power (percent of maximum PTO power*)	Ratio of maximum PTO power to usable drawbar power
Firm	67	1.5
Tilled	56	1.8
Soft or Sandy	48	2.1

*If Tractor does not have a maximum PTO power rating, use an assumed rating equal to 86 percent of maximum engine power.

Using the figures from the previous example, calculate the PTO horsepower equivalent to the drawbar horsepower for the firm soil condition. Use one of two formulas.

PTO HP x .67 = Drawbar HP
PTO HP x .67 = 149
PTO HP = 222.4

Drawbar HP x 1.5 = PTO HP
149 Drawbar HP x 1.5 = PTO HP
PTO HP = 223.5

Table 2. Soil Resistance

Operation	Draft/foot of width (pounds)	Typical speed (miles per hour)	Drawbar horsepower per foot of width
Plowing (8 inches deep)			
Gumbo	1250	4.0	13.3
Clay	1050	4.0	11.2
Loam	950	4.5	11.4
Sandy Loam	700	5.0	9.3
Loam	350	5.0	4.7
Chisel Plowing (8 inches deep)			
Hard, Dry	800	4.0	8.5
Medium Clay Loam, Good Moisture	500	5.0	6.7
Sand, Sandy Loam	200	6.0	3.2
Field Cultivator			
Heavy Clay Soils or Dry and Hard Conditions	650	4.0	6.9
Clay Loam	450	5.0	6.0
Sandy Loam	300	5.0	4.0
Sand	150	6.0	2.4
Tandem Disk Harrow			
Heavy Draft	300	4.0	3.2
Medium Draft	200	5.0	2.7
Light Draft	10	6.0	1.6
Offset or Heavy Tandem Disk			
Heavy Draft	400	4.0	4.3
Medium Draft	325	5.0	4.3
Light Draft	250	6.0	4.0
One-Way Disk			
Heavy Draft	400	4.0	4.3
Medium Draft	300	5.0	4.0
Light Draft	200	6.0	3.2

INFORMATION SHEET #5

Selecting Equipment

Problem:

You need to purchase a planter for a planting operation in which 30-inch rows are to be used. The field efficiency is 70 percent and the speed of the tractor is 6.5 miles per hour. A total of 480 acres need to be planted in six 10-hour work days. What size of planter should be purchased?

Solution:

1. Calculate acres per hour.
    a. 6 days x 10 hours per day = 60 hours
    b. 480 acres + 60 hours = 8 acres per hour
2. Calculate the required width.
    a. Width in feet = (acres per hour x 8.25) + (speed x efficiency)
    b. (8 x 8.25) + (6.5 x 0.70) = 66 + 4.55 = 14.5 feet
3. Calculate to 30-inch rows.
    a. 14.5 feet x 12 inches per foot = 174 inches wide
    b. 174 inches width + 30 inch rows = 5.8 or 6 rows

    NOTE: Always round up to nearest size of planter available.

Based on these calculations, a 6-row planter should be purchased.

INFORMATION SHEET #6

What Size Machinery for Your Farm?

The amount of work accomplished by a field machine is influenced by the size and speed of the machine, the field efficiency, the time available to do the work, the amount and quality of labor, the type and condition of the soil, and the breakdown time.

The size of machine needed to accomplish work on the farm is a function of the time available and the machine capacity. The most critical time in grain crop production is the date of seeding. Thus farmers should gear their total operation to take advantage of optimum seeding dates. Time of harvest of grain crops often influences yields, but this is not as critical as the date of planting.

The form on the next page of this information sheet provides a procedure for the farmer to estimate the size of machinery needed for the farm. List all operations performed during the critical period and determine the time available for each operation. Machine size should meet or slightly exceed the size indicated in the "standard size needed" column of the worksheet.

Table 1. Performance Rates of Farm Implements

	Speed (mph)*	Field efficiency (percent)**
Corn head	3	70
Grain head	3	70
Tillage implements	5	80
Rotary hoe	9	85
Row cultivator	4	75
Planter	5	60
Grain drill	5	70
Fertilizer equipment	5	70
Spraying equipment	5	60
Mower	5	80
Mower conditioner, hay rake	5	80
Forage harvester, blower	3	70
Hay baler, forage wagon	4	75
Manure spreader	5	70

*Speeds may vary 50 percent above the rates listed.
**Field efficiencies may vary 20 percent above or below the percentages listed.

Table 2. Calendar Days Favorable for Field Work by Selected Periods and Selected Regions of Illinois

Period	Total Calendar days	Average number of favorable days			Number of favorable days available 5 out of 6 years		
		Northern	Central and Eastern	Southern	Northern	Central and Eastern	Southern
March 30 - April 12	14	4.1	5.9	3.0	1.7	2.0	1.0
April 13 - April 26	14	7.9	6.9	6.4	5.0	3.6	2.4
April 27 - May 10	14	9.2	7.9	7.8	6.2	5.1	4.2
May 11 - May 24	14	8.6	7.5	8.0	5.4	3.9	4.2
May 25 - June 7	14	10.2	9.1	9.4	8.2	6.5	6.0
June 8 - June 21	14	9.7	9.5	9.6	6.5	6.4	7.0
June 22 - July 5	14	10.8	10.0	10.8	8.6	7.1	8.0
August 30 - Sept 12	14	11.9	11.3	12.1	9.3	9.8	9.5
Sept 13 - Sept 26	14	10.2	9.6	10.8	6.6	7.2	8.2
Sept 27 - Oct 10	14	10.7	9.4	10.3	6.7	7.9	7.6
Oct 11 - Oct 24	14	11.5	10.8	10.6	8.8	10.0	8.1
Oct 25 - Nov 7	14	10.4	10.5	10.6	6.4	7.2	7.6
Nov 8 - Nov 21	14	10.3	10.0	8.6	7.9	8.1	5.6
Nov 22 - Dec 6	14	6.5	7.5	4.8	5.9	3.7	1.6

SOURCE: Unpublished data from the Illinois Cooperative Crop Reporting Service; computation of statistical measure of dispersion of the data about the average by R.A. Hinton, Department of Agricultural Economics, University of Illinois at Urbana-Champaign.

	Operation or machine (1)	Size (2)	Width (inches) (3)		Speed (mph) (4)		Field efficiency (percent) (Table 1) (5)		Field capacity (acres per hour) (6)	Acres per year (7)	Hours to cover (7 ÷ 6) (8)	Hours available (Table 2) (9)	Ratio of capacity available to cover (8 ÷ 9) (10)	Computed size needed (inches) (3 x 10) (11)	Standard size needed (12)
Ex.	*Chisel Plow*	*18'*	*216*	x	*4.5*	x	*.80*	÷ 100 =	*7.776*	*600*	*77.16*	*100*	*.7716*	*166.67*	*14'*
Ex.	*Planter*	*12 x 30"*	*360*	x	*4.5*	x	*.70*	÷ 100 =	*11.34*	*600*	*52.91*	*80*	*.6614*	*238.09*	*8 x 30'*
				x		x		÷ 100 =							
				x		x		÷ 100 =							
				x		x		÷ 100 =							
				x		x		÷ 100 =							
				x		x		÷ 100 =							
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				x		x		÷ 100 =							
				x		x		÷ 100 =							
				x		x		÷ 100 =							

INFORMATION SHEET #7

Fixed Cost Estimates

1. Depreciation — See sample calculations on Information Sheets #8 - #10.
2. Taxes — Use an estimate of 1 - 2% of the value of the machine at the beginning of each year.
3. Shelter — Use an estimate of 1 - 2% of the value of the machine at the beginning of each year.
4. Insurance — Use an estimate of 0.25 - 0.50% of the value of the machine at the beginning of each year.
5. Interest — Use the appropriate rate (usually between 10 and 18 percent).

1714

INFORMATION SHEET #8

Straight Line Depreciation

Calculate the straight line depreciation for a $40,000 tractor over eight years with a salvage value of 20% of its purchase price.

$$\text{Average Annual Depreciation} = \frac{\text{Purchase price - Salvage value}}{\text{Years of Ownership}}$$

$$4{,}000 = (40{,}000 - 8{,}000) \div 8$$

Year	Depreciation	Remaining Value End of Year
1	$4,000.00	$36,000.00
2	$4,000.00	$32,000.00
3	$4,000.00	$28,000.00
4	$4,000.00	$24,000.00
5	$4,000.00	$20,000.00
6	$4,000.00	$16,000.00
7	$4,000.00	$12,000.00
8	$4,000.00	$8,000.00

INFORMATION SHEET #9

Sum-of-the-Digits Depreciation

Calculate the sum-of-the-digits depreciation for a $40,000.00 tractor over 8 years with a salvage value of $8,000 after 8 years.

Sum-of-the-digits depreciation = 1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 = 36

Year	Depreciation	Remaining Value End of Year
1	8/36 x $32,000 = $7,111.11	$32,888.89
2	7/36 x $32,000 = $6,222.22	$26,666.67
3	6/36 x $32,000 = $5,333.33	$21,333.34
4	5/36 x $32,000 = $4,444.44	$16,888.90
5	4/36 x $32,000 = $3,555.56	$13,333.34
6	3/36 x $32,000 = $2,666.67	$10,666.67
7	2/36 x $32,000 = $1,777.78	$8,888.89
8	1/36 x $32,000 = $ 888.89	$8,000.00

INFORMATION SHEET #10

Declining Balance Depreciation

Calculate the declining balance depreciation for a $40,000.00 tractor over 8 years (use a rate of depreciation 1 1/2 times the straight line rate of depreciation, which is 1/8).

$$\text{Remaining value} = \text{cost} \times [1 - (\text{rate of depreciation} / \text{life in years})]^{\text{age in years}}$$

$$= \$40{,}000 \times [1 - (1.5 / 8)]^{y}$$

Year	Depreciation	Remaining Value End of Year
1	$7,500.00	$32,500.00
2	$6,093.75	$26,406.25
3	$4,951.17	$21,455.08
4	$4,022.83	$17,432.25
5	$3,268.55	$14,163.70
6	$2,655.69	$11,508.01
7	$2,157.75	$9,350.26
8	$1,753.18	$7,597.08

INFORMATION SHEET #11

Variable Cost Estimates

1. **Fuel Costs** — Consumption is dependent upon the operation being performed, the type of fuel being used, and the size of the engine.

Average Fuel Consumption

Fuel type	Gallons per hour per maximum PTO HP
Gasoline	0.068
Diesel	0.048
LP-Gas	0.080

Example:

A 140 PTO HP Tractor is being used with an average annual use. How many gallons of fuel per hour will be used by this tractor?

Gasoline 0.068 x 140 HP = 9.52 gallons/hr
Diesel 0.048 x 140 HP = 6.72 gallons/hr
LP Gas 0.080 x 140 HP = 11.20 gallons/hr

2. **Lubricant Costs** — Use an estimate of 15 percent of the fuel cost.

3. **Repair Costs** — This estimate is dependent upon how much the machine is used and the maximum expected operating life of the machine (see Table 3 in Information Sheet #14).

INFORMATION SHEET #12

Tractor Maintenance and Usage Record

Tractor ID ______________________________

Date	Maintenance Repairs	$	Engine		Tot hrs	Gal fuel	Operation/Location
			Beg hrs	End hrs			

INFORMATION SHEET #13

Equipment Maintenance and Usage Record

Equipment ID ____________________

Date	Maintenance Repairs	$	Hours of Use	Location of Operation	Comments

1720

INFORMATION SHEET #14

Cost of Using Machinery

This form will help in determining machinery costs. For example, if you want to use a tractor as a power unit, complete this form for the tractor. Then, to figure the cost of using an accompanying machine such as a plow, disk, or PTO baler, use a second copy of this worksheet and enter the result from line 13 of the first worksheet on line 12 of the second worksheet.

Computation of Total Ownership and Operating Costs of Machinery

1. Units of work per hour = $\dfrac{\text{\_\_\_\_\_\_ width (in) x \_\_\_\_\_\_ speed (mph) x \_\_\_\_\_\_ field efficiency}}{100}$ = ______
2. Hours per year = ______ acres covered + ______ units per hour (line 1) = ______
3. Total hours of use = ___________ hours per year (line 2) x years of use. = ______
4. Total ownership costs (Tables 1 and 2) for years of use = ______%
5. Total repair costs for ______ hours of use (line 3):
   (______ total hours of use x ______ percent [Table 3]*) + ______ number of hours (Table 3) = ______%
6. Total ownership and repair costs as a percent of manufacturer's list price (line 4 + line 5) = ______%
7. Total ownership and repair costs = $______ (mlp) x ______ percent (line 6) = $______
8. Annual ownership and repair costs = $______ (line 7) + ______ years of use = $______
9. Hourly ownership and repair costs = $______ (line 7) + ______ hours of use (line 3) = $______
10. Fuel and lubricants per hour = ______ PTO HP x
    .069 for gasoline
    .0504 for diesel x ______ price per gal =$ ______
    .0828 for LP Gas
11. Labor cost per hour = $______
12. Cost per hour of using accompanying machinery** = $______
13. Total costs per hour (lines 9 + 10 + 11 + 12) = $______
14. Total costs per acre = ______ (line 13) + ______ acres per hour (line 1) = $______

*To compute the repair costs for the hours used if not equal to the hours of use in Table 3, go to the next larger number of hours in the table. This figure becomes the denominator. Enter the percent of repair costs and the actual hours of use as the numerator.

**To figure the cost of an accompanying machine, use another copy of this worksheet and then enter the result from line 13 of that worksheet on line 12 of this worksheet.

Table 1. Accumulated Total Ownership Cost of Farm Tractors as a Percent of Manufacturer's List Price

Age (years)	Remaining "as is" values (percent)	Selected interest rates, pct. 10	12	15	18
New	100				
1	62.6	49.4	51.4	54.4	57.4
2	57.6	61.9	62.5	70.0	74.9
3	53.0	73.4	77.8	84.4	91.0
4	48.7	84.1	89.5	97.7	105.9
5	44.8	93.8	100.3	109.7	119.6
6	41.2	102.8	110.1	121.1	132.1
7	37.9	111.0	119.2	131.4	143.7
8	34.9	118.6	127.5	140.9	154.3
9	32.1	125.6	135.2	149.6	164.0
10	29.5	132.0	142.3	157.7	173.1
Purchase adjustment*		1.12	1.14	1.17	1.20

Table 2. Accumulated Total Ownership Cost of Other Farm Machines as a Percent of Manufacturer's List Price

Age (years)	Remaining "as is" values (percent)	Selected interest rates, pct. 10	12	15	18
New	100				
1	53.1	58.9	60.9	63.9	66.9
2	47.0	71.4	74.4	79.0	83.6
3	41.6	82.4	86.4	92.4	98.4
4	36.8	92.4	97.0	104.3	111.5
5	32.6	100.8	196.4	114.7	123.1
6	28.8	108.5	114.8	117.9	133.4
7	25.5	115.3	122.1	132.3	142.5
8	22.6	121.2	138.6	139.5	150.5
9	20.0	126.6	134.3	146.0	157.6
10	17.7	131.3	139.4	151.7	163.9
Purchase adjustment*		1.12	1.14	1.17	1.20

NOTE: Accumulated total ownership costs include depreciation, insurance at 0.5 percent, housing at 1.5 percent, and interest at selected rates.

*For each 1 percent reduction in purchase price of a machine, reduce the ownership cost by the percent listed.

Table 3. Accumulated Hours and Repair Costs as a Percent of Purchase Price

	1/4 Life accumulated		1/2 Life accumulated		3/4 Life accumulated		Full Life accumulated	
Machine	hours	cost	hours	cost	hours	cost	hours	cost
2 and 4 Wheel Drive Tractors	2,500	9.8%	5,000	29.7%	7,500	56.8%	10,000	90.0%
Crawlers	4,000	8.7%	8,000	26.4%	12,000	50.5%	16,000	80.0%
Combines	500	2.7%	1,000	9.5%	1,500	19.6%	2,000	33.0%
Cotton Pickers, Corn Pickers, and Cotton Strippers	500	8.2%	1,000	24.7%	1,500	47.3%	2,000	75.0%
Planters and Drills	250	8.2%	500	24.7%	750	47.3%	1,000	75.0%
Mowers	250	29.7%	500	73.1%	750	123.7%	1,000	180.0%
Plows, Swathers, Balers, Balewagons, Loose Hay Stack Wagons, and Forage Harvesters	500	13.2%	1,000	32.5%	1,500	55.0%	2,000	80.0%
Disks, Chisel-Plows, and Field Cultivators	500	5.3%	1,000	18.8%	1,500	38.7%	2,000	65.0%

SOURCE: Adapted from data from Agricultural Engineering Department, University of Illinois, and the Agricultural Engineering Yearbook.

NOTE: Accumulated repair cost estimates in this table do not include the effect of inflation over the period of ownership.

INFORMATION SHEET #15

Figuring Custom Rates and Machine Rental Rates

Custom field operation rates are charges made for the use of field equipment, the time of the operation, necessary mechanical power, other supplies furnished such as tractor fuel and wire or twine for the baler, and an allowance for risk and overhead. Rental rates are for the use of the power unit and the machine only. There are two methods of establishing the charge for a particular operation. One is by determining the market rates charged. The other is the actual cost of performing the operation or providing the machine services.

Custom Rate Cost Index

In the absence of current market rates, index numbers of prices paid by farmers for selected classes of expenditures can be used to adjust historical market rates for increased costs. An index of prices paid by U.S. farmers for selected production items directly related to the costs of providing custom farm operations are presented in Table 1. The weightings of the four items for the calculated custom rate cost index are as follows: tractors and self-propelled machinery 30%; other machinery and implements 25%; fuel and energy 15%; and farm wage rates 30%. The base for each index is 1977. The rightmost column lists the percent of change from the previous year. The custom rate cost index assumes custom rates are based on costs of performing operations and no change in the efficiency of performing the operation.

Costs of Owning and Operating Power and Implements

The cost of using replacement machines is another guide to establishing and adjusting custom rates. The short cut method of computing the direct use costs for individual power units and implements is illustrated by the example in the form on page two.

The direct use costs for typical sized machines at current replacement cost and at average performance levels are presented in Table 2. These direct use costs include depreciation, interest, insurance, repairs, fuel and labor. There has been no allowance for profits, management, overhead or risk in these calculations.

There are three direct use values presented in Table 2. The value in the first column covers all direct use costs of power, implement, fuel, and labor. The data in the second and third columns are for situations where the power and equipment units are rented out. Costs for both tractor and implement are included in the second column. The third column has the ownership and operating costs for the implement only.

Table 1. Calculated Custom Rate Cost Index and Annual Change, 1977-1987

	Index for prices paid by U.S. farmers for production items; 1977 = 100*					
Year	Tractors and self-propelled machinery	Other machinery implements	Fuel and energy	Wage rates	Estimated custom rate cost index**	Percent change from previous year
1977	100	100	100	100	100.0	—
1978	109	108	104	107	107.4	7.4
1979	121	119	137	117	121.7	13.3
1980	136	132	188	126	139.8	14.9
1981	152	146	213	136	154.8	10.7
1982	165	160	211	143	164.0	5.9
1983	174	171	202	148	169.6	3.4
1984	181	180	201	151	174.8	3.0
1985	178	183	201	154	175.5	0.4
1986	174	184	162	160	170.5	-2.8
1987	174	186	166	170	174.5	2.8

*Derived from Agricultural Prices, SRS, USDA.

**Tractors and self-propelled machinery weighted by 30%; other machinery and implements 25%; fuel and energy 15%; and wage rates 30%.

Table 2. Method of Computing Direct Costs of Operating Power and Implements
(+ Estimated return for management, overhead, and risk)

		Power Unit (tractor or self-propelled unit)	Implement	Total
1.	Machine	Tractor	Chisel Plow	
2.	Size	180 HP	15 feet	
3.	Purchase price	$70,000.00	$4,250.00	
4.	Ownership and repair cost (Table 3)	0.00041	0.00177	
5.	Hourly ownership and repair cost (line 3 x line 4)	$28.70	$7.52	
6.	Fuel and Lubrication, cost per hour[a]	$10.21	$0.00	
7.	Total power and implement, cost per hour (line 5 + line 6)	$38.91	$7.52 =	$46.43
8.	Labor cost per machine-hour on the job[b]			$8.66
9.	Total costs per machine-hour on the job for operation (line 7 + line 8)			$55.09
10.	Units of work per machine-hour on the job (acres, bushels, tons, bales)[c]			6.5
11.	Total cost per unit of work (line 9 + line 10)			$8.47
			10% rate	25% rate
12.	Adjustment for risk, time for moving from job, other overhead, and profit margin (10 to 25 percent of line 11)		$ 0.85	$ 2.12
13.	Estimated machine hire rate per unit of operation		$ 9.32	$ 10.59

---

[a] Calculate fuel and lubrication cost per hour according to the formula below. In the example given, the boldfaced items are used for the calculation.

PTO HP x fuel factor x lubrication factor x price per gallon = fuel cost per hour

	.069 for gasoline		0.75 for light load				
180 x	**.0504 for diesel**	x	1.00 for average load	x	$0.90	=	$10.21
	.0823 for LP		**1.25 for heavy load**				

[b] Calculate labor cost per machine-hour according to the formula below. In the example given, the boldfaced item is used for the calculation,

				1.05 for tillage operations		
8.25	x	1	x	1.10 for harvesting operations	=	$8.66
				1.20 for planting, spraying		

[c] Calculate units (in this example, acres) of work per machine-hour according to the formula below.

width in inches x speed in mph x field efficiency x .01 = acres per hour

180 x 4.5 x .80 x .01 = 6.5

Table 3. Amount of Assumed Use, Assumed Ownership and Repair Costs per Hour per Dollar of the List Price, and Rate of Performance Coefficients, to be Used in Estimating Costs of Operating Power and Implements

	Number of years of use	Annual hours of use	Cost of ownership and repair / hour / dollar of list price	Speed (mph)	Field-efficiency coefficient
Tractor	10	400	.00041	...	...
Basic combine	5	250	.00094	...	...
Corn head	5	150	.00167	2.7	.65
Grain head	5	100	.00217	3.0	.70
Heavy tillage tools*	10	100	.00177	4.5	.80
Light tillage tools**	10	100	.00150	5.0	.80
Planter only	8	75	.00278	4.5	.70
Planter with attachments	8	75	.00278	4.5	.65
Grain drill	8	75	.00278	4.5	.70
Fertilizer equipment	8	75	.00256	4.5	.65
Spraying equipment	8	75	.00276	5.0	.65
Mower	10	100	.00175	5.0	.80
Mower-conditioner	10	100	.00167	5.0	.80
Hay rake	10	100	.00167	5.0	.80
Hay baler, forage wagon	10	100	.00153	3.5	.75
Forage harvester, blower	10	100	0..166	2.5	.60
Grain wagon	10	100	.00150	...	...
Manure spreader	10	100	.00156	5.0	.70
Liquid manure spreader	10	100	.00156	...	...

NOTE: Costs were based on 5, 8, or 10 years of depreciated life, an interest rate of 12 percent, insurance at .5 percent, and housing at 1.5 percent of the remaining value of the beginning of the year. The purchase price was assumed to be 90 percent of the manufacturer's list price, plus freight and the dealer's setup cost.

*Include moldboard plow, chisel plow, field cultivator, and row cultivator.
**Include disk harrow, spike tooth harrow, and rotary hoe.

INFORMATION SHEET #16

Various Formulas for Machinery Management

1. Theoretical capacity = [speed (mph) x width (feet)] ÷ 8.25
2. Field efficiency = effective field capacity ÷ theoretical capacity
3. Effective field capacity = total acres ÷ total hours
4. Speed (mph) = distance ÷ [time (minutes) x 88]
5. EFC (Effective field capacity) = TFC (theoretical field capacity) x (field efficiency ÷ 100)
6. Work = force x distance
7. Horsepower = [force (pounds) x speed (mph)] ÷ 375
8. Drawbar horsepower = [force (pounds) x speed (mph)] ÷ 375
9. Speed = (drawbar horsepower x 375) ÷ draft (pounds)
10. Draft = (horsepower x 375) ÷ speed (mph)

STUDENT ACTIVITIES

STUDENT WORKSHEET #1 — Sample Test Questions

STUDENT WORKSHEET #2 — Estimating Costs of Grain Drying and Storage Systems

For additional activities, teachers may refer to the "Suggested Teaching Activities and Procedures" section in the Instructor's Guide.

STUDENT WORKSHEET #1

Sample Test Questions

Use VAS Unit *Fitting Machinery and Equipment to the Farm* as a reference for this worksheet.

1. What is the difference between durable capital and working capital? Give an example of each.

2. The process of substituting power and machinery for labor is frequently referred to as ____________________ .

3. How has mechanization influenced farm labor requirements and farm production?

4. How can the economic principle "rate of substitution" be used to evaluate the replacement of labor with machinery?

5. What is machinery depreciation?

6. Other than feed costs and interest charges, machinery and equipment costs often exceed all other individual costs. True or False (Circle one).

7. Define the term "fixed costs" (as applied to machinery and equipment).

8. List four fixed costs of machinery and equipment.

   a.
   b.
   c.
   d.

9. Define the term "operating costs" (as applied to machinery and equipment).

10. List three variable costs of machinery and equipment.

    a.
    b.
    c.

11. Explain why the cost per unit of operation of farm machinery and equipment decreases as the amount of use increases.

12. Of all fixed costs, the cost for _______________ is usually the greatest.

13. What decision would you make given a situation where you must choose whether to purchase additional power units and tillage equipment or specialized harvesting machines.

14. What justification should accompany the purchase of an *additional* tractor?

15. List three factors, other than the original cost, that must be considered when deciding what brand of comparable machinery or equipment to purchase.

    a.
    b.
    c.

16. List three advantages and three disadvantages of buying second-hand machines.

Advantages	Disadvantages
a.	a.
b.	b.
c.	c.

17. List three common alternatives to purchasing new equipment.

    a.
    b.
    c.

18. One of the greatest advantages of doing custom work is that it enables you to spread (fixed, operating) costs over more acres or hours of work. (Circle best answer.)

19. List three practices that can be done to improve machine efficiency.

    a.
    b.
    c.

STUDENT WORKSHEET #1 — Key

Sample Test Questions (refer to VAS Unit #U2039)

1. What is the difference between durable capital and working capital? Give an example of each.

   Durable capital can be used many times and working capital can be used only once. Answers for example may vary.

2. The process of substituting power and machinery for labor is frequently referred to as *mechanization.*

3. How has mechanization influenced farm labor requirements and farm production?

   Mechanization has helped labor to become more efficient in accomplishing production activities, causing decreased labor requirements while at the same time increasing productivity.

4. How can the economic principle "rate of substitution" be used to evaluate the replacement of labor with machinery?

   Given the costs of capital and labor along with the ratio of each required to maintain a level of output, the least-cost ratio can be estimated. This is the most economical point to operate at.

5. What is machinery depreciation?

   The portion of the original cost of the machine that is charged against the business each year.

6. Other than feed costs and interest charges, machinery and equipment costs often exceed all other individual costs. *True*.

7. Define the term "fixed costs" (as applied to machinery and equipment).

   Those costs that remain the same regardless of how much or how little use is made of the machinery and equipment.

8. List four fixed costs of machinery and equipment.
   a. *Depreciation*
   b. *Interest*
   c. *Insurance*
   d. *Taxes*
   e. *Shelter*

9. Define the term "operating costs" (as applied to machinery and equipment).

   Those costs that will vary with the use of the machine. The greater the amount of use, the larger the amount of operating costs and vice versa.

10. List three variable costs of machinery and equipment.
    a. *Repair*
    b. *Fuel*
    c. *Lubrication*
    d. *Labor*

11. Explain why the cost per unit of operation of farm machinery and equipment decreases as the amount of use increases.

    The greater the use, the lower the fixed costs per unit of use while the operating costs remain fairly constant. In other words, low costs per unit of use are possible only if you can spread the fixed costs over enough units of use.

12. Of all fixed costs, the cost for *depreciation* is usually the greatest.

13. What decision would you make given a situation where you must choose whether to purchase additional power units and tillage equipment or specialized harvesting machines.

    A good rule to follow is to equip the farm with basic power units and tillage equipment before purchasing specialized harvesting machines. The use of harvesting machines can usually be obtained from custom operators or through exchange work.

14. What justification should accompany the purchase of an *additional* tractor?

    You can justify an extra tractor only if it saves more in labor, convenience, and operating costs each year than the amount of its annual fixed costs.

15. List three factors, other than the original cost, that must be considered when deciding what brand of comparable machinery or equipment to purchase.

    a. *Serviceability of the unit*
    b. *History of resale price*
    c. *Availability of parts*
    d. *Personal preference*
    e. *Time before obsolescence*
    f. *Projected operating costs*

16. List three advantages and three disadvantages of buying second-hand machines.

Advantages	Disadvantages
a. *Low original cost*	a. *Greater risk*
b. *Low fixed cost*	b. *Quicker obsolescence*
c. *Utilization of mechanical abilities of owner to save costs*	c. *Possible high repair costs*
d. *More power (speed) for the money*	d. *Greater chance of breakdown during critical and peak use.*

17. List three common alternatives to purchasing new equipment.

    a. *Buying used machinery*
    b. *Purchasing and using machinery cooperatively*
    c. *Exchanging machinery or labor for machinery usage*
    d. *Hiring custom work*
    e. *Renting or leasing machine*

18. One of the greatest advantages of doing custom work is that it enables you to spread (fixed, operating) costs over more acres or hours of work.

19. List three practices that can be done to improve machine efficiency.

    a. *Keeping machines in proper adjustment*
    b. *Operating machines near capacity*
    c. *Keeping machines in proper repair*
    d. *Combining trips (operations) when possible*

STUDENT WORKSHEET #2

Estimating Costs of Grain Drying and Storage Systems

You are exploring the possibility of purchasing a 20,000-bushel bin with a drying floor and stir unit. In addition to the bin you will need to purchase an auger to permit filling and unloading. Using the information below, complete the worksheet that follows.

a.	Price of bin	$14,000.00	h.	Ending moisture %	14.0
b.	Price of drying unit	$7,000.00	i.	LP gas cost / gal (cents)	30.5
c.	Price of auger	$2,000.00	j.	Electricity cost / kwh (cents)	3
d.	Sampling equipment	$100.00	k.	Field loss %	3
e.	Annual labor hours (10 prep, 35 operation)	45	l.	Shrink in dry matter %	.5
f.	Value of labor/hour	$5.00	m.	Price of corn / bu	$2.50
g.	Harvest moisture %	22.5			

Type of Dryer ______________________ Type of Storage ______________________________

Size ______________________ Size ______________________________

Annual volume ______ bushels; average moisture _____ %; ending moisture ___ %

Components	Investment costs*	Percent annual cost	Annual fixed costs
Dryer units			
1. Bins		11	
2. Bin-unloading units		18	
3. Aeration fans		18	
4. Heater units		18	
5. Stir dryer		18	
6. Batch		17.3	
7. Continuous-flow dryer		17.3	
8. Total dryer units			
Storage units			
9. Bins		11	
10. Bin-unloading units		11 or 18**	
11. Aeration fans		11 or 18**	
12. Total storage units			
Other equipment			
13. Augers		17.3	
14. Moisture meter and sampling equipment		27.3	
15. Wagons		17.3	
16. Total			

Annual labor cost

17. Dryer preparation __________ hours

18. Dryer operation __________ hours

19. Total drying labor __________ hours x $______ labor rate per hour = $ __________

Operating costs **Cost per bushel**

20. LP gas ________ cents/gal x 0.0165 x __________ points moisture = $____________

Electricity for drying

21. Batch-in-bin ________ cents/kwh x 0.015 x __________ points moisture = ____________
22. Batch-in-bin stir dryer ________ cents/kwh x 0.0113 x __________ points moisture = ____________
23. Electric dryer ________ cents/kwh x 0.3343 x __________ points moisture = ____________
24. Automatic batch ________ cents/kwh x 0.0106 x __________ points moisture = ____________
25. Continuous flow ________ cents/kwh x 0.0106 x __________ points moisture = ____________

Tractor PTO for dryer

26. Automatic batch (__ cents x ______________ points moisture) = ____________
27. Continuous flow (__ cents x ______________ points moisture) = ____________

Electricity for storage

28. Augers and aeration __________ cents/kwh x (.05 to .1) = ____________
29. Total fuel and power costs $ ____________

Summary of drying and storage costs

30. Dryer units $ __________ + __________ bushels dried = ____________
31. Storage units $ __________ + __________ bushels stored = ____________
32. Other equipment $ __________ + __________ bushels handled = ____________

Annual fixed costs

33. Dryer units $ __________ + __________ bushels dried = ____________
34. Storage units $ __________ + __________ bushels stored = ____________
35. Other equipment $ __________ + __________ bushels handled = ____________
36. Labor costs $ __________ + __________ bushels handled = ____________
37. Total annual fixed costs (lines 33 + 34 + 35 + 36) $ ____________

Operating costs

38. Fuel and power costs = ____________

Grain losses

39. ______________ % field loss - 2.6% = ________ % net loss
40. ______________ % net loss x $ ______________ price of corn = ____________
41. Shrink in dry matter __________ % x $ ____________ price of corn = ____________
42. **TOTAL** cost of conditioning and storing (lines 37 + 38 + 40 + 41) $ ____________

*Include delivery and installation costs of equipment on the farm.

**If used for only one bin, figure annual costs at 11 percent; if moved from bin to bin (maximum use), 18 percent may be used.

STUDENT WORKSHEET #2 — Key

Estimating Costs of Grain Drying and Storage Systems

You are exploring the possibility of purchasing a 20,000-bushel bin with a drying floor and stir unit. In addition to the bin you will need to purchase an auger to permit filling and unloading. Using the information below, complete the worksheet that follows.

a.	Price of bin	$14,000.00	h.	Ending moisture %	14.0
b.	Price of drying unit	$7,000.00	i.	LP gas cost / gal (cents)	30.5
c.	Price of auger	$2,000.00	j.	Electricity cost / kwh (cents)	3
d.	Sampling equipment	$100.00	k.	Field loss %	3
e.	Annual labor hours (10 prep, 35 operation)	45	l.	Shrink in dry matter %	.5
f.	Value of labor/hour	$5.00	m.	Price of corn / bu	$2.50
g.	Harvest moisture %	22.5			

Type of Dryer *Bin with Drying Floor and Stir Unit* Type of Storage __________

Size *20,000 bu* Size __________

Annual volume *20,000* bushels; average moisture *22.5* %; ending moisture *14.0* %

Components	Investment costs*	Percent annual cost	Annual fixed costs
Dryer units			
1. Bins	*14,000*	11	*1,540*
2. Bin-unloading units		18	
3. Aeration fans		18	
4. Heater units		18	
5. Stir dryer	*7,000*	18	*1,260*
6. Batch		17.3	
7. Continuous-flow dryer		17.3	
8. Total dryer units	*21,000*		*2,800*
Storage units			
9. Bins		11	
10. Bin-unloading units		11 or 18**	
11. Aeration fans		11 or 18**	
12. Total storage units			
Other equipment			
13. Augers	*2,000*	17.3	*346*
14. Moisture meter and sampling equipment	*100*	27.3	*27.3*
15. Wagons		17.3	
16. Total	*2,100*		*373.3*

Annual labor cost

17. Dryer preparation *10* hours
18. Dryer operation *35* hours
19. Total drying labor *45* hours x $ *5.00* labor rate per hour = $ *225.00*

Operating costs **Cost per bushel**

20. LP gas ___30.5___ cents/gal x 0.0165 x ___8.5___ points moisture = $___.0428___

Electricity for drying

21. Batch-in-bin ______ cents/kwh x 0.015 x ______ points moisture = ______
22. Batch-in-bin stir dryer ___3.0___ cents/kwh x 0.0113 x ___8.5___ points moisture = ___.0029___
23. Electric dryer ______ cents/kwh x 0.3343 x ______ points moisture = ______
24. Automatic batch ______ cents/kwh x 0.0106 x ______ points moisture = ______
25. Continuous flow ______ cents/kwh x 0.0106 x ______ points moisture = ______

Tractor PTO for dryer

26. Automatic batch (__ cents x ______ points moisture) = ______
27. Continuous flow (__ cents x ______ points moisture) = ______

Electricity for storage

28. Augers and aeration ___3.0___ cents/kwh x (.05 to .1) = ___.0015___
29. Total fuel and power costs $ ___.0472___

Summary of drying and storage costs

30. Dryer units $ ___21,000___ + ___20,000___ bushels dried = ___1.05___
31. Storage units $ ______ + ______ bushels stored = ______
32. Other equipment $ ___2,100___ + ___20,000___ bushels handled = ___.105___

Annual fixed costs

33. Dryer units $ ___2,800___ + ___20,000___ bushels dried = ___.14___
34. Storage units $ ______ + ______ bushels stored = ______
35. Other equipment $ ___373.3___ + ___20,000___ bushels handled = ___.0187___
36. Labor costs $ ___225___ + ___20,000___ bushels handled = ___.0113___
37. Total annual fixed costs (lines 33 + 34 + 35 + 36) $ ___.17___

Operating costs

38. Fuel and power costs = ___.0472___

Grain losses

39. ___3.0___ % field loss - 2.6% = ___0.4___ % net loss
40. ___0.4___ % net loss x $ ___2.50___ price of corn = ___.01___
41. Shrink in dry matter ___0.5___ % x $ ___2.50___ price of corn = ___.0125___
42. **TOTAL** cost of conditioning and storing (lines 37 + 38 + 40 + 41) $ ___.2397___

*Include delivery and installation costs of equipment on the farm.

**If used for only one bin, figure annual costs at 11 percent; if moved from bin to bin (maximum use), 18 percent may be used.

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agricultural Engineering/Mechanization

PROBLEM AREA: Manufacturing, Distributing, Selling, and Servicing Agricultural Equipment

RELATED PROBLEM AREAS:

1. Understanding Basic Business Organization (Central Core Cluster)
2. Marketing Agricultural Products and Services
3. Planning and Organizing the Agribusiness
4. Advertising and Selling Agricultural Products and Services
5. Operating the Agribusiness
6. Repairing and Maintaining Agricultural Equipment

PREREQUISITE PROBLEM AREA(S): None

LEVEL: Preparatory

OCCUPATIONAL TASKS ADDRESSED:

Agricultural Business and Management Cluster

Duty B: Performing Sales Duties

1. Determine customer needs
2. Conduct sale

Duty H: Managing the Business

1. Conduct inventory of merchandise
2. Purchase machinery and equipment
3. Utilize computerized inventory system

STATE GOALS FOR LEARNING

In planning the instruction for this problem area, teachers can promote the development of several student learning objectives which are related to the State Goals for Learning in Physical Development/Health, Social Sciences, and Language Arts. These objectives are listed on the Learning Assessment Plan forms included on the following page(s). Those learning objectives marked with an asterisk (*) are taken from the sample lists provided by the Illinois State Board of Education.

CORE

Illinois Agricultural Core Curriculum

Agricultural Education 124 Mumford Hall 1301 W. Gregory Drive University of Illinois Urbana, IL 61801

Director: Dale A. Law, Ed.D.
Principal Investigator: Jerry D. Pepple, Ed.D.
Research Assistant: Douglas L. Stockley

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88/89
Agricultural Business and Management
Agricultural Engineering/Mechanization

Illinois Agricultural Core Curriculum Rev.

Submission Date ____________________
☐ Original submission ☐ Revision
Page _____ of _____

I. LEARNING AREA *(check one)*
☒ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☐ Sciences ☐ Physical Development/Health

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)
COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐
District Name
City

Contact Person: ____________________
Title: ____________________
Phone: (   )

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to use spoken language effectively in formal and informal situations to communicate ideas and information and to ask and answer questions.

III. LEARNING OBJECTIVES

By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:

III. LEARNING OBJECTIVES	IV. ASSESSMENT A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	V. EXPECTATIONS Percent of Students Expected to Achieve Objective
1. Prepare a detailed outline for an oral presentation.					
2. Use physical movements and visual aids in expressive ways appropriate to the situation.					
3. Organize information in an oral message.					
4. Use imagination to develop new ideas in an oral presentation.					
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Agricultural Business and Management
Agricultural Engineering/Mechanization

Manufacturing, Distributing, Selling, and Servicing Agricultural Equipment

Manufacturing, Distributing, Selling, and Servicing Agricultural Equipment

Illinois Agricultural Core Curriculum Rev.

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

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Submission Date ____________
☐ Original submission ☐ Revision
Page ____ of ____

(Affix label or complete district information.)

COUNTY	DISTRICT	ESC

District Name

City

Contact Person: ____________
Title: ____________
Phone: (   )

I. LEARNING AREA *(check one)*

☐ Language Arts
☐ Mathematics
☐ Sciences
☐ Fine Arts
☒ Social Sciences
☐ Physical Development/Health

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to understand and analyze events, trends, personalities, and movements shaping the history of the world, the United States, and Illinois.

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Identify the scientific achievements and technological developments which spurred the industrial revolution and the birth of the modern nation-states.					
2. Identify individual inventors (of agricultural equipment) who contributed to the development of the modern nation-states.					
3. Evaluate the contributions (related to agricultural machinery and equipment) of significant men and women in world history.					

Agricultural Business and Management
Agricultural Engineering/Mechanization

Illinois Agricultural Core Curriculum Rev.

Submission Date ____________

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I. LEARNING AREA *(check one)*

☐ Language Arts ☐ Fine Arts
☐ Mathematics ☒ Social Sciences
☐ Sciences ☐ Physical Development/Health

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

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(Affix label or complete district information.)

COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐

District Name

City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to understand and analyze comparative political and economic systems, with an emphasis on the political and economic systems of the United States.

Contact Person: ____________

Title: ____________

Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Analyze the relationships between savings, business investment, and employment.					
*2. Understand the concept of inflation, deflation, and economic cycles.					
*3. Analyze how changes in each of the following would likely influence economic behavior: profits, wages, and interest rates.					
*4. Understand how the introduction of new technology can affect producers and consumers.					
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Manufacturing, Distributing, Selling, and Servicing Agricultural Equipment

Agricultural Business and Management
Agricultural Engineering/Mechanization

Submission Date ____________________
☐ Original submission ☐ Revision
Page _____ of _____

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☐ Sciences ☒ Physical Development/Health

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)

COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐

District Name

City

Contact Person: ____________________
Title: ____________________
Phone: ( )

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to understand consumer health and safety, including environmental health.

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
1. Identify the operator safety features that are included in the design of agricultural equipment.					
2. Compare and contrast the differences in safety features between past and present agricultural equipment.					
3. Identify the operator environment improvements that have been designed and included in farm machinery (combines and tractor cabs).					
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					1745

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Illinois Agricultural Core Curriculum Rev.

Submission Date ____________

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I. LEARNING AREA *(check one)*

☐ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☒ Sciences ☐ Physical Development/Health

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)

COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐

District Name

City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will have a working knowledge of the social and environmental implications and limitations of technological development.

Contact Person: ____________

Title: ____________

Phone: ( )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Identify materials now in use that are replacing natural resources.					
*2. Analyze the quality of life.					
*3. Compare and contrast the quality of life 100 years ago with current life styles.					
*4. Relate advertising techniques to consumer demands.					
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ISBE 41-78 (1/86)

Agricultural Business and Management
Agricultural Engineering/Mechanization

Manufacturing, Distributing, Selling, and Servicing Agricultural Equipment

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agricultural Engineering/Mechanization

PROBLEM AREA: Manufacturing, Distributing, Selling, and Servicing Agricultural Equipment

STUDENT LEARNING OBJECTIVES

Upon completion of their study of this problem area, students will be able to:

1. Understand the history of the U.S. agricultural equipment manufacturing industry.
2. Identify the structure and organization of the agricultural equipment manufacturing industry.
3. Identify the functions of the agricultural equipment manufacturer.
4. Identify the functions of the agricultural equipment wholesaler.
5. Identify the functions of the agricultural equipment retailer.
6. Understand that agricultural equipment is distributed in an international market.
7. Understand how agricultural equipment franchises are used in establishing retail outlets.
8. Differentiate between wholesale selling and retail selling and understand the role of each in the sales process.
9. Identify the various criteria that should be used when choosing a retail outlet location.
10. Identify the various areas located in an agricultural equipment retail store and their function/arrangement.
11. Understand what human factors are considered when designing machines.
12. Identify several human factors that are considered when designing agricultural equipment.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agricultural Engineering/Mechanization

PROBLEM AREA: Manufacturing, Distributing, Selling, and Servicing Agricultural Equipment

PROBLEMS AND QUESTIONS FOR STUDY

1. What is the developmental history of some of our major agricultural equipment manufacturers?
2. What inputs are required to manufacture agricultural equipment?
3. Trace the flow of a specific piece of agricultural equipment from manufacturing to purchase by the ultimate consumer (farmer).
4. What are the various steps required to manufacture agricultural equipment?
5. What is the function of a good agricultural equipment wholesaler?
6. What is the function of a good agricultural equipment retailer?
7. What is a franchise, and what is its purpose in the agricultural equipment industry?
8. Identify agricultural equipment that is exported from and imported to the U.S.
9. How does wholesale selling of agricultural equipment differ from retail selling of agricultural equipment?
10. What role does the manufacturer, wholesaler, and retailer each have in servicing agricultural equipment?
11. What measures can be taken by the retailer to prevent customer equipment downtime?
12. What are the various areas (indoors and outdoors) found at an agricultural equipment retail store?
13. What needs to be considered when choosing a location for an agricultural equipment retail store?
14. Before a machine is designed for manufacture, what information needs to be gathered?
15. What considerations need to be made when designing agricultural equipment for operator comfort and control?
16. What differences exist in operator comforts and controls between different brands and ages of agricultural equipment?
17. Why is equipment appearance considered as a human factor when designing agricultural equipment?
18. How has instrumentation found in agricultural equipment changed over the past 10 to 15 years?
19. How is instrumentation design related to safety?

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agricultural Engineering/Mechanization

PROBLEM AREA: Manufacturing, Distributing, Selling, and Servicing Agricultural Equipment

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES

1. Given a list of topics about farm equipment and machinery inventors, have students choose a topic of interest to them for research. The assignment format, length, and required illustrations should be announced at the beginning of the project.

2. Take a class trip to visit a collector of antique farm machinery. Ask that students record such details as date of manufacture, company name, name of inventor, and other pertinent data. Contrast design changes (improvements) between models over time.

3. Ask a collector of miniature farm machinery to visit with your class and, if possible, to display a collection. Use this display to stimulate student interest in the various types of farm machines and manufacturers that have occurred over time.

4. As a class project, have students identify farm tractor manufacturers and their headquarters. Contact each manufacturer and request that they send you information about their manufacturing and distribution network. Once information has been received, divide the class into groups representing various manufacturers for an in-depth review of the material that has been collected. Have each group prepare written and oral reports to be presented to the entire class. Have students compare and contrast the various manufacturing and distribution systems.

5. Take a class trip to visit a farm machinery dealership. If possible, take a tour of the facilities and meet with the owner(s) to discuss the business organization and the responsibilities of the different employees. Have students prepare a written report that includes the following information:

   a. A diagram of the layout of the dealership (inside and outside).
   b. A map showing the location of the dealership sales and service region and the positions of the nearest competitors.
   c. An organizational chart of the types of agricultural equipment sold and serviced by the dealership.
   d. One to two paragraphs describing each of the types of agricultural equipment sold and serviced by the dealership.
   e. One to two paragraphs describing the network among this dealership, the wholesaler, and the manufacturer (include new equipment and parts).
   f. One to two paragraphs describing the type of records that the dealership must keep (accounting, sales, inventory).

6. Have students identify equipment and components that have been manufactured outside of the U.S. Students should compare and contrast different aspects of foreign manufactured equipment and components with their domestic counterparts. Comparisons should include price, quality, and the ability to compete in the U.S. market. Wherever possible, the same comparisons should be made for the use of U.S. equipment in foreign markets.

7. For a class project, assign the students the task of starting a new agricultural equipment dealership within the school district. Decisions will need to be made concerning:

   a. Location.
   b. Lot requirement.
   c. Start-up costs.
   d. Legal requirements.
   e. Inventory requirements.
   f. Projected sales and service area.
   g. Minimum building requirements.
   h. Franchise requirements.
   i. Employees.
   j. Shop equipment.
   k. Structure of business organization.

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INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agricultural Engineering/Mechanization

PROBLEM AREA: Manufacturing, Distributing, Selling, and Servicing Agricultural Equipment

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES (con't.)

8. Given the task of designing the layout of an agricultural equipment dealership, have students map the main building and lots with service roads, entrances, parking, displays, and storage areas. Also, have them draw the various areas within the main building including the shop, parts department, and customer service area. A written description should accompany the drawing. (This activity could be carried a step further by having the students construct scale models of their layouts.)

9. Have each student select one major piece of agricultural equipment for a sales demonstration. The student should learn everything possible about the piece of equipment he or she will be selling, and when possible should acquire handout information explaining the features of the piece of equipment. Students should be expected to role play the position of salesperson as completely as possible. These mock-sales may occur in front of the class or on a one-to-one basis, whichever is most appropriate for your class. (Refer to the problem area *Advertising and Selling Agricultural Products and Services* for a more complete discussion of the sales function.)

10. Bring an old and a new tractor of similar horsepower from the same manufacturing company to the school. Given copies of the specifications of both tractors, students should identify changes in design. This analysis should be as comprehensive as time and information will allow. Each major system should be considered. Once the design changes have been noted, students should prepare a paper describing the changes along with a short explanation to justify each change or in some cases a rebuttal as to why a change was not warranted.

11. Have students discuss the human factors considered when designing agricultural equipment today. Given the chance to design their own cab, have students illustrate, describe, and justify changes they would make in the cabs of today.

12. Take a class trip to a major machinery manufacturer. Besides touring the plant, ask to meet and speak with personnel involved with design and marketing. Based on what they learned during this tour, students should prepare a report that includes all of the aspects of the manufacturing and distribution processes that were encountered.

13. You should refer to the problem areas *Advertising and Selling Agricultural Products and Services* and *Repairing and Maintaining Agricultural Equipment* for a more complete discussion of the selling and servicing of agricultural equipment.

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agricultural Engineering/Mechanization

PROBLEM AREA: Manufacturing, Distributing, Selling, and Servicing Agricultural Equipment

REFERENCES

*1. *Retailing Farm and Light Industrial Equipment.* (1983). Mayeau, M.M. AVI Publishing Company, Division of Van Nostrand Reinhold, 115 Fifth Avenue, New York, NY 10003. (212) 254-3232.

2. *Farm Machinery Mechanisms.* Hunt, D.R., Garver, L.W. Iowa State University Press, 2121 S. State Avenue, Ames, IA 50011. (515) 292-0140.

3. *Distinguished Lecture Series.* American Society of Agricultural Engineers, 2950 Niles Road, St. Joseph, MI 49085. (616) 429-0300. A number of volumes in this series may prove useful. These reports contain some introductory material, but the majority of the information is highly technical.

   No. 1, Power Steering for Agricultural Tractors.
   No. 2, Design of Operator Enclosures for Agricultural Equipment.
   No. 3, Agricultural Tire Design Requirements and Selection Consideration.
   No. 4, Design of Agricultural Tractor Transmission Elements.
   No. 5, Agricultural Tractor Hitches — Analysis of Design Requirements.
   No. 6, The Human Factor in Farm and Industrial Equipment Design.
   No. 7, Operator Seals for Agricultural Equipment.
   No. 8, Quick Action Couplings: The Tractor to Implement Hydraulic Interface.
   No. 9, Agricultural Load Sensing Hydraulic Systems.
   No. 10, Managing Tomorrow's Product Safety and Liability: The Engineers Challenge.
   No. 11, The Application and Installation of Diesel Engines in Agricultural Equipment.
   No. 12, The Environment of Electrical/Electronic Components on Agricultural Equipment.
   No. 13, Reliability in Design.

4. *John Deere Tractors and Equipment, Volume One, 1837-1959.* MacMillan, D., Russel, J. American Society of Agricultural Engineers, 2950 Niles Road, St. Joseph, MI 49085.

5. *John Deere Tractors 1918-1987.* (1987). Deere and Company. American Society of Agricultural Engineers, 2950 Niles Road, St. Joseph, MI 49085.

6. *Farm Tractors: 1950-1975.* Larsen, L. American Society of Agricultural Engineers, 2950 Niles Road, St. Joseph, MI 49085.

7. *The Agricultural Tractor: 1855-1950.* Gray, R.B. American Society of Agricultural Engineers, 2950 Niles Road, St. Joseph, MI 49085.

8. *The Grain Harvesters.* Quick, G., Buchele, W. American Society of Agricultural Engineers, 2950 Niles Road, St. Joseph, MI 49085.

9. *150 Years of International Harvester.* Wendel, C.H. Crestline Publishing Co., 1251 N. Jefferson Avenue, Sarasota, FL 34237. (813) 955-8080.

10. *Wheels of Farm Progress.* McKinley, M. American Society of Agricultural Engineers, 2950 Niles Road, St. Joseph, MI 49085.

11. *Implement and Tractor.* (Journal). Intertec Publishing Corporation, P.O. Box 12901, Overland Park, KS 66212.

*Indicates highly recommended reference

INSTRUCTIONAL RESOURCES

These resources are intended for use by teachers in planning and teaching the materials for this problem area and may be adapted to fit the teaching method(s) used.

INFORMATION SHEET #1 — Early Merchandising and Manufacturing of Farm Equipment

INFORMATION SHEET #2 — Partial Outline of Corporate Development of Ten Farm Equipment Companies

INFORMATION SHEET #3 — Manufacturing Farm Equipment

INFORMATION SHEET #4 — The Business Structure of the Farm Equipment Industry

INFORMATION SHEET #5 — Obtaining a Franchise

INFORMATION SHEET #6 — Distribution of Agricultural Equipment

INFORMATION SHEET #7 — Retail Store Arrangement Principles

INFORMATION SHEET #8 — Designing Agricultural Equipment

INFORMATION SHEET #9 — Other Sources of Information

TRANSPARENCY MASTER #1 — Distribution of Agricultural Equipment

TRANSPARENCY MASTER #2 — Agricultural Equipment Product Flow (Manufacturing through Distribution)

TRANSPARENCY MASTER #3 — Functions of the Machinery Manufacturer (with discussion guide)

TRANSPARENCY MASTER #4 — A Manufacturer's Minimal Organization

TRANSPARENCY MASTER #5 — Typical Organization for Large Farm Machinery Manufacturing Corporations

TRANSPARENCY MASTER #6 — Functions of Machinery Wholesalers and Branch Houses (with discussion guide)

TRANSPARENCY MASTER #7 — Functions of the Machinery Retailer (with discussion guide)

TRANSPARENCY MASTER #8 — Typical Areas Found at an Agricultural Equipment Dealership

TRANSPARENCY MASTER #9 — Building Location and Other Factors

TRANSPARENCY MASTER #10 — Three Basic Human Body Types

TRANSPARENCY MASTER #11 — Proportional Differences in Races

TRANSPARENCY MASTER #12 — Angles of Comfort for Vehicular Seating

INFORMATION SHEET #1

Early Merchandising and Manufacturing of Farm Equipment

The merchandising practices in the early days of farm mechanization might best be described as "cutthroat." Commonly, a line of equipment was handled in a particular territory by a distributor or jobber who sold many other lines too. The local dealer may have been the blacksmith, the hardware store, or a man best described as an order taker. Competition was keen, credit was freely given to make a sale, almost anything would be taken in trade, and repairs and follow-up service were not given much time by the seller. However, there is at least one instance of the responsibility felt by a manufacturer for his product. Jerome I. Case is said to have made a train trip out to a farm to answer a complaint about one of his early threshers. After working with it for about a day with no success, he called for some matches and burned the machine where it stood. He did not want it said that one of his machines would not operate.

The advertising of the day was flowery, with operation of a patented mechanism explained in great detail and with a certain amount of relish. The printed matter was often accompanied by artwork and the implements themselves were brightly painted and decorated with stripes and figures. Testimonial letters were also used extensively in advertising.

The early years of farm mechanization were a time of innovation, a period of trial and error, an era when fortunes could be made with a good idea. Many mechanisms were invented, promoted, and sold; but only those that were truly superior and which matched the limited manufacturing technology of the day survived. Few new mechanisms are introduced today that haven't been tried before by someone in the farm machinery manufacturing business.

The marketing and distribution practices of the early years have undergone considerable change. Consolidation of equipment companies into large corporations dates from about 1900. Although such mergers were delayed to some extent by an antitrust suit, most of today's large companies have a long history of mergers, purchases, and amalgamations.

INFORMATION SHEET #2

Partial Outline of Corporate Development of Ten Farm Equipment Companies

1. Allis Chalmers Co., Milwaukee, WI was formed in 1901 by a merger of the following Milwaukee firms:

   - Edward P. Allis Company
   - The Reliance Works, Milwaukee, WI (1847)
   - Faser and Chalmers Company
   - Gates Iron Works
   - Dickson Manufacturing Company

   The company later purchased the following firms:

   1905 — Bullock Electric Manufacturing Company
   1927 — Pittsburgh Transformer Company, Pittsburgh, PA
   1928 — Monarch Tractor Company, Springfield, IL
   1929 — LaCrosse Plow Company, LaCrosse WI
   1931 — Advance-Runely Company, LaPorte, IN
   1932 — American Brown-Bover Company, Boston, MA
   1938 — Brenneis Manufacturing Company, Oxnard, CA
   1952 — LaPlante-Choute Manufacturing Company, Cedar Rapids, IA
   1953 — Buela Company, Harvey, IL
   1955 — Gleaner Harvester Corporation, Independence, MO
   1959 — S. Morgan Smith Company, York, PA (1877)

2. Caterpillar Tractor Company, Peoria, IL was formed in 1925 by the merger of:

   - C. L. Best Tractor Company, San Leandro, CA (1885)
   - Holt Manufacturing, Stockton, CA (1886)

   In 1926 a subsidiary formed with Western Harvester of Stockton, CA.

   The company later purchased the following firms:

   1928 — Russel Grader Manufacturing Company, Minneapolis, MN
   1951 — Trackson Company, Milwaukee, WI

3. Deere and Company, Moline, IL was organized in 1868 from John Deere Plow Company of Moline (1847). The company later purchased the following firms:

   1911 — Deere and Mansur of Moline, IL and St. Louis, MO (1877); Van Brunt Company, Horicon, WI; Marseilles Sheller, Marseilles, IL (1870); Kemp and Burpee, Syracuse, NY (1881); Richardson Manufacturing Company, Worchester, MA; Syracuse Chilled Plow Company, Syracuse, NY (1876); and Dain Manufacturing Company, Ottumwa, Iowa
   1918 — Waterloo Boy Tractor Company, Waterloo, Iowa (1893)
   1930 — Wagner-Langemo Thresher
   1936 — Caterpillar's combine line
   1956 — Heinrich Lanz, Mannheim, Germany

4. Ford Motor Company, Detroit, MI purchased Woods Brothers Thresher Company, Des Moines, IA, in 1950.

5. International Harvester Company, Chicago, IL was formed in 1902 by a merger of:

   - McCormick Harvesting Machine Company, Chicago, IL (1879), formerly McCormick Reaper Works, Chicago, IL (1847)
   - Deering Harvester Company, Chicago, IL
   - Plano Manufacturing Company, Milwaukee, WI
   - Warder, Bushnell & Glessner (Champion Line), Springfield, OH

   The company later purchased the following firms:

   1903 — D. M. Osborne & Company, Auburn, NY (1856)
   1904 — Keystone Company, Rock Falls, IL; Weber Wagon Company, Chicago, IL; and Aultman-Miller Company, Akron, OH

   1918 — As part of the settlement of an anti-trust suit, the company agreed to divest itself of the Osborne, Champion, and Milwaukee lines.

   1919 — Parlin & Orendorff, Canton, IL (1842) and Chattanooga Plow Company, Chattanooga, TN
   1920 — American Seeding Machine Company, Richmond, IN

6. J. I. Case Company, Racine, WI was formed in 1928 from the J. I. Case Threshing Machine Company, Racine, WI (1844). The company later purchased the following firms:

1919 — Grand Detour Plow Company, Dixon, IL (1837)
1928 — Emerson-Brantingham Company, Rockford, IL (1852), which also purchased Osborne Line from International Harvester in 1918
1957 — American Tractor Corporation, Churubusco, IN, which was itself purchased by the Kern County Land Company in 1967; Kern County Land Company was purchased by Tenneco in 1967
1968 — Drott Manufacturing Company, Wausau, WI and Davis Manufacturing Company, Wichita, KS

7. Massey-Ferguson, Toronto, Canada (1955) was originally formed as Massey-Harris in 1891 by the merger of:

- Daniel Massey, New Castle, Ontario, Canada (1847), which also purchased Woods Mower in 1861
- John Harris, Brantford, Ontario, Canada (1846)

The company later purchased the following firms:

1891 — Patterson & Bros, Woodstock, Ontario (1850) and J. O. Wisner, Son & Company, Brantford Ontario (1850), which was affiliated with W. H. Verity & Sons, Exeter, Ontario (1857).
1893 — Corbin Disc Harrow Company, Prescott, Ontario
1895 — Bain Wagon Company
1904 — Kemp Manure Spreader Company, Stratford, Ontario
1910 — Johnston Harvester Company, Batavia, NY (1871)
1928 — J. I. Case Plow Works, Racine, WI
1931 — An interest in H. V. McKay, Australia
1955 — Harry Ferguson Incorporated, Detroit, MI (Firm name changed)
1959 — Perkins Engines, Ltd., Peterborough, England

8. New Holland, New Holland, PA (1903). The company later purchased the following firms:

1942 — Hertzler and Zook Company, Belleville, PA
1947 — was purchased by the Sperry Corporation
1948 — Dellinger Manufacturing Company, Lancaster, PA
1958 — Smoker Elevator Company, Smoketown, PA
1962 — Haro-Bed, Fowler, CA
1964 — Claeys, Zedelgem, Belgium

9. New Idea, Coldwater, OH (1899). The company later purchased the following firms:

1930 — Sandwich Manufacturing Company, Sandwich, IL
1945 — became a division of Avco Corporation
1951 — Horn Manufacturing Company, Ft. Dodge, IA
1953 — Ezee-Flow Corporation
1963 — Uni-Tractor line from Minneapolis-Moline

10. White Farm Equipment Company, Hopkins, MN was formed in 1970 by the merger of:

- Oliver Corporation, Chicago, IL (1944), which was originally the South Bend Iron Works, South Bend, IN (1868), renamed the Oliver Chilled Plow Works (1901)
- Minneapolis-Moline, Minneapolis, MN (1929)

Oliver Farm Equipment was formed with the merger of:

- Hart-Parr Company, Charles City, IA (1901)
- Nichols and Shephard, Battle Creek, MI (1886)
- American Seeding Machine Company, Springfield, OH (1903), which was itself formed by the merger of:
  - Superior Drill, Springfield, OH (1863)
  - Bickford and Juffman, Macedon, NY (1848)
  - Empire Drill Company, Shortsville, NY
  - Brennan and Company, Louisville, KY
  - Hoosier Drill Company, Richmond, IN

The American Seeding Machine Company later purchased the following firms:

1907 — A. C. Evans Company, Springfield, OH
1909 — P. P. Mast Company (Buckeye), Springfield, OH (1856)

The Oliver Farm Equipment Company later purchased the following firms:

1943 — Ann Arbor Machine Company, Shelbyville, IL and Economy Baler Company, Ann Arbor, MI (1882)
1944 — Cleveland Tractor Company, Cleveland, OH (1916)
1952 — A. B. Farquhar, York, PA (1857)
1953 — Be-Ge Manufacturing Company, Gilroy, CA (1934)
1960 — was purchased by White Motor Company, Cleveland, OH
1962 — Cockshutt Farm Equipment Ltd., Brantford, Ontario

Minneapolis-Moline, was formed by a merger of:

- Minneapolis Steel and Machinery Company (Twin City Tractor), Minneapolis, MN (1902)
- Minneapolis Threshing Machine Company, Hopkins, MN (1887)
- New Moline Plow Company, Moline, IL (1919), whose original company was Candee, Swan and Company, Moline (1865) and was incorporated as Moline Plow Company in 1870. The company later purchased the following firms:

1892 — Mandt Wagon Company, Stoughton, WI
1912 — Monitor Drill Company, Minneapolis and Henney Buggy Company, Freeport, IL
1915 — Universal Tractor Manufacturing Company, Columbus, OH
1919 — Adriance, Platt and Company, Poughkeepsie, NY
1924 — Milwaukee line from International Harvester

The Minneapolis-Moline Company later purchased the following firms:

1948 — B. F. Avery and Sons, Louisville, KY which had purchased the Champion line of International Harvestor in 1924

1963 — was purchased by White Motor Company, Cleveland, OH

INFORMATION SHEET #3

Manufacturing Farm Equipment

Organization

Farm machinery mechanisms are made by manufacturers in search of a return on their investment. To secure a profit, manufacturers find that they must organize their people into departments having specific responsibilities. Small companies have at least a simple organization. Larger companies may have a complex organization of personnel. A successful manufacturer will staff its departments with appropriately trained people.

Product Conception

In the competitive business climate of the U. S., a manufacturer can become interested in a new product for one primary reason — PROFIT! The product planning manager develops plans for new products. The manager is assisted by other departments including market research (estimates how many can be sold), engineering (designs and tests the product), manufacturing (determines how to program and build the product and its probable manufacturing costs), planning and procurement (determines where and when the product will be built and what are the material and shipping costs), finance (determines the source and cost of the financing for factory space, machine tools, production tonnage, raw material and inventory), and marketing and management (estimates how much it will cost to advertise, hold introduction meetings and service schools, sell the product, and collect the money from sales). Numerous product proposals are made to the company president or chief executive, who selects and approves those which best support his or her total responsibility to the owners of the business, the stockholders, and the board of directors. The objectives of the company are necessarily long range and are related to identified markets and to associated products. Planning periods of from four to ten years are common.

Product Development

After management has decided to proceed with the manufacture of a new machine, a follow-through plan is needed to arrange for the necessary money, manpower, buildings, machine tools, and materials. These items must be brought together; the material processed; the product assembled, stored, sold, and shipped; and the sales money collected. The manufacturer must assume responsibility for warranty, and repair parts supply and service for perhaps ten years. Such a program requires initial action, later a detailed plan, and, finally a production and sales plan. The company's top executive relies on a product manager to develop and document the working plans for all these steps.

The timing required to bring a plan into action varies with the degree of innovation and the complexity of the product design. This planning time may take many months. The engineering design, testing, and release of drawings will take from six to twenty-four months (possibly longer if an accident or weather adversity upsets the refining of the design during testing). The factory preparation of machine tools and production toolage requires from six months to a year. The testing of the acceptable quality and product integrity of the first production units may reveal parts requiring redesign or correction, leading to a series of delays of days or weeks.

The seasonal use of farm machinery complicates the timing and profit plans. For example, if a new corn planter is to be introduced, every step of production, quality approval, sales training, advertising, service training, and repair parts supply must be completed before February of the year it will be introduced. If strikes, acts of God, or errors cause delays beyond this date, the introduction may have to be deferred. A deferral decision is very costly, upsetting the profit plan for twelve to fifteen months. Some alternate proposal might be considered, such as emergency high-cost production of the critical parts, limitation of sale to the late-season areas, or other combinations of changes in plans.

Over the years manufacturers have established patterns of development, design, and manufacture which reduce the cost and the time spent on new product development. These patterns involve the use of standardized parts, the use of materials other than iron and steel, the development of new manufacturing techniques by specialized outside suppliers, and the contracting of parts to other well-equipped and reliable manufacturers.

Standardized parts and assemblies are more commonly used today than ever before. An example of such an assembly is the standardized wheel and hub for accepting automotive tire sizes. The assembly — complete with wheel, hub, studs, nuts, bearings, seals, and hub cap, all on a stub axle — is available from an automated factory at a lower cost than that at which it could be sold by a manufacturer who designs and builds a few hundred units. Added value of standard parts comes from the proven design which reduces the risk of field failures, availability on relatively short lead time (order date to delivery date), and the wide availability of replacement parts. A low cost level is assured because usually two or more makers are competing for the business.

There is also a trend toward using more nonferrous materials in the standard parts and assemblies. Cost saving results as suppliers of these materials become more experienced and efficient. Parts can be custom made of light metal, plastic, or special materials when a high volume item such as the individual feed run of a grain drill can justify the cost of dies and molds. Sintered iron bushings and feed wheels, for instance, are replacing the more expensive iron castings. Often the assembling factory avoids all machining because of the high degree of precision possible by using permanent molds and dies in the special machine tools now available.

When a manufacturer has established a very efficient special machine which reduces the labor cost and does a higher quality job, he can often arrange to process parts for others at a mutually agreeable cost saving. The cost of the special machine is spread over perhaps twice as many product units per year.

Planning for Distribution

The inventory of the wide variety of completed machines is a costly item especially during periods of high interest rates. Seasonal items must be carried for more than one year if forecasts are even slightly inaccurate. The proliferation of products has resulted in thousands of models, sizes, attachments, and accessories. The possible combinations of these products number in the millions. Order processing and inventory control is now assisted by computerized record keeping and communication to a central point, so that all available stock is known and can be shipped promptly. Centralized mixing or master warehouses are often established where products from two or more factories can be included in a single shipment giving the maximum assurance of completely filling each order as scheduled and at a reasonable transportation cost. The retailer's stock orders are filled at the closest field warehouse at regular intervals. Urgent and emergency orders are filled immediately from the most convenient stock. One central office controls and records all transactions by computer.

Assembly and Parts

Machines are now assembled more by the manufacturer than in the past. Engineers' instructions are understood and enforced better as to torquing bolts, tune-up procedures, and the important initial lubrication. Thus, the problems of lost or misplaced parts, unfamiliar workmen, and lost or unread instructions (which often occurred when many bundles arrived at a retailer's store) are almost eliminated. Some manufacturers and wholesalers have been known to arrange an erecting service, often by the truck operator who delivers it, which appeals to many retailers. The retailer is very conscious of the favorable impression on the customer which comes from smooth trouble-free operation during the first few hours of use of a new machine.

Repair parts and accessories are usually programmed, manufactured, and controlled as a separate division or department since the parts sales of tractor and implement manufacturers is expected to be 25-30 percent of the total sales. Centralized control of all production, shipping, and inventory by electronic data processing of all transactions is a usual practice. The parts warehouses are established at central distributing points often entirely separate from the warehouses for whole goods. Liaison between the product planning manager and the parts manager is maintained to assure service parts for new product entries. Subsequently, the sales history is used to determine the amount of stock to be provided for anticipated orders without excessive inventory.

World Trade

Manufacturers of farm and industrial equipment have worldwide opportunities for sales. The free trade policy of the United States for farm machinery continues to encourage imports and exports, thus keeping the cost to farmers lower than it would be if each country had its own design and tooling for a smaller volume of sales. Complete units or component assemblies are imported or exported by manufacturers to attain lowest cost for the high volume items and to obtain acceptable cost levels on the low volume, special models (i.e., special narrow-tread vineyard tractors). New import brand names are appearing often in the United States market. Even the import of used but nearly new tractors is stimulated when changing wage levels, monetary exchange rates, tariff rates, and government actions combine to provide a profitable trade opportunity. However, the possibility that some of these factors may suddenly change with little or no advance warning must be recognized.

INFORMATION SHEET #4

The Business Structure of the Farm Equipment Industry

A potential buyer contacts the retailer, negotiates a purchase, and places an order. The retailer in turn purchases from distributors (or the distribution departments of manufacturers), and the distributor purchases from manufacturers or other wholesalers.

Retailers

Retailers of farm and industrial equipment are close to the users. They are easy to find in trade centers and may be small individually owned-and-operated dealerships or a larger incorporated businesses. There may be from two to fifty employees. The buildings, grounds, and facilities may be meager, but the trend is toward adequate yard areas, display rooms, offices, parts departments, and service shops. A competent retail operation enhances the value of trade-marked products and the potential sales volume for them. This enhancement explains why major companies have a number of company-owned stores and encourage locally owned dealerships by assisting in the initial financing and management of them.

The North American Equipment Dealer's Association in St. Louis, MO, consists of thirty-one state and regional associations, and has a long history of conventions, committees, and business services which aid in the improvement of the retailer's business practices. Examples of a state association are the Illinois Farm Equipment Association in Peoria, IL, and the California Equipment Dealers' Association.

Wholesalers

The wholesaling of farm and industrial equipment consists of selling to retailers, delivering the machinery, and collecting the money due. Only the larger manufacturers handle these activities entirely with their own employees. For 50 to 100 years most tractor or "full-time" companies had well-stocked branch houses at many locations, where wholesalers (sometimes called jobbers or distributors) served dealers with equipment and supplies from numerous smaller or specialized factories. Goods were received from the factory in large lots, sometimes called job lots, and distributed to retailers in smaller quantities. The salespeople (blockman, territory manger, district manager, etc.) reported to the branch house or distributor.

The more recent trend is towards separation of the management, sales, and collecting functions from the physical distribution. Salespeople and territory managers usually report to a sales office which may or may not be nearby. The product is moved from the factory to the retailer directly or perhaps to a regional "mixing" warehouse where economic-sized shipments of individualized and often specialized items are arranged. Technical knowledge and quality control are retained by the manufacturer. Complete shipments with minimum set-up time and cost please the retailer and the user.

Many of the wholesalers in the U.S. and Canada are members of the Farm Equipment Wholesalers Association (FEWA), Iowa City, IA, which offers business services, committee meetings, conventions, and a unique "dating session" whereby interested manufacturers can meet individual wholesalers during their concurrent conventions once a year.

Manufacturers

The thousand or more factories serving the farm and industrial equipment market are of a wide variety of types and sizes, because in a very real way they must match the full variety of products involved.

Manufacturers have found that joint efforts are rewarding for some matters of common interest. The Farm and Industrial Equipment Institute (FIEI), Chicago, IL, was established in 1893 and serves the industry through eleven councils, seventeen standing committees, and its representation on six joint committees serving broad industry needs.

Because of the interest in selling through wholesalers, many medium- and small-sized manufacturers are members of the Farm Equipment Manufacturer's Association (FEMA), St. Louis, MO. FEMA is a participant in the FEWA dating sessions, and it offers management services to its members. Member companies with small office staffs can take advantage of these services, including auditing freight bills, providing tax and personnel policy information, etc.

Farm equipment companies expend hundreds of millions of dollars annually for research and development. Excitement comes with the development of new models, new mechanisms, and innovations in design. New machines attract the attention of users and advertising writers to the engineering departments of the manufacturers. But inventions and innovations are only a small part of the total cost and effort expended each year. A great many man-hours of work are spent at the drafting board, in the shops, in the laboratories, and in field tests. Tremendous cost is required to produce the first machine in a new product design. The hundreds or thousands of units that are sold afterward are really just copies of the master design. The manufacturer hopes to sell enough of the copies to pay for the original development costs and to allow for a reasonable profit.

Employees

Men and women with diverse professional training are found as employees of manufacturers, wholesalers, and retailers. The engineer is found in many departments and in many levels of responsibility from field test to top management. These individuals frequently are members of the American Society of Agricultural Engineers (ASAE) and the Society of Automotive Engineers (SAE).

Many people other than engineers are employed in this industry. Professional people such as accountants, lawyers, economists, office managers, scientists, and computer operators, are all needed to meet the challenges facing their firms. An even larger group of workers including secretaries, factory workers, truck drivers, and shop people carry the real burden of the firm's success.

Agricultural mechanization specialists have direct involvement in the on-the-job functioning success of today's specialized equipment. They understand the basic mechanisms, the applications for each machine, the operation and maintenance requirements, and the business procedures which apply. Therefore they are qualified for positions of responsibility in sales or service with retailers, wholesalers, or manufacturers.

World Trade

The world trade in farm industrial equipment has roots in the export of U.S. machines since the late nineteenth century plus expanded importation of equipment since World War II. The favorable climate for world trade has led to the development of worldwide shopping for products having attractive performance and price. Some of the tractor manufacturers import models from overseas factories. Combines made in the U.S. are widely distributed in other countries. The competitive pressure on manufacturers to keep costs low has led to import and export of component parts and assemblies to produce equipment that is both economical and reliable.

INFORMATION SHEET #5

Obtaining a Franchise

Prospective dealers may obtain a franchise to sell farm equipment by negotiating with a representative of an equipment manufacturer for a Dealer's Sale Agreement or a Company Dealer Contract. Also, it is not uncommon for the manufacturer to instigate a search for competent individuals to contact for a franchise. The prospective dealer must have the ability to buy, sell, and service equipment, and the area in question must have potential for sales.

Dealers may negotiate with more than one manufacturer for a franchise. In actual practice, manufacturers frown on having competitive major brands under one roof. The reason for this policy centers around the difficulty of one dealer properly financing and representing a multiple-brand operation in one community.

Federal law prohibits the assignment of specific sales territories. The logistics of delivery and service usually tend to restrict dealers to definite areas. A dealer is expected to develop the full sales potential of his surrounding area. This area must be large enough to provide a profitable business. Marginal trade territories lead to distressed merchandising which tends to disturb the pricing structure of a territory.

Some companies may require a bond to cover purchase of inventories, fixed assets, and miscellaneous start-up costs. Others may negotiate a title retention agreement, which stipulates the company's ownership and control of its goods.

Farm equipment dealers may finance their inventories by various methods. The larger, more expensive items of equipment are usually obtained through a floor plan arrangement with the manufacturer. The high cost of borrowing money is creating a trend towards shortening this floor plan period. In all cases, full payment is required as soon as the equipment is sold to a customer.

When a dealer pays for a machine before the designated due date, many manufacturers allow a prepayment discount. Also, a few farm equipment manufacturers offer volume discounts to dealers. These discounts are based on a dealer's total net purchases within a prescribed time period.

Sales agreements may be terminated by either party or by mutual agreement, depending on the contract. Termination can also occur if dealer or manufacturer fails to abide by the terms of the contract.

INFORMATION SHEET #6

Distribution of Agricultural Equipment

Wholesale Selling

Wholesaling, whether by independent distributors or by manufacturer's sales departments, depends on personal contact with retailers. Here is where "salesmanship" and pressure methods as were practiced in the 1900s have matured into a business relationship that is based on mutual respect and trust. *Territory managers*, representing the factory or wholesaler, communicate regularly so that all the knowledge, manpower, and assets of their organization assist the retailer in making each retail transaction complete, satisfactory, and profitable.

Sales to retailers usually are the responsibility of the territory salespeople or manager working under the supervision of a regional or area sales manger. The territory manager's duties include establishing dealerships, writing stock orders, planning advertising and sales promotion activities, conducting product sales training for retail sales people, arranging financing sources, planning seasonal sales campaigns, arranging parts and accessory departments, reporting progress, and working with staff departments of the manufacturer.

Retail Selling

Retail selling, like wholesale work, has progressed. The retail salesperson is the key person in the distribution system. Today, the salesperson usually represents a retailer with departmental services, and manufacturers with a wide variety of products. The salesperson knows how these services can fit the customer's farm or industrial needs, and knows the current value of trade-in goods. The salesperson probably has an incentive income arrangement. The satisfaction and pay of salespeople are limited only by how wisely and how ambitiously they work.

Frequently a retailer or retail salesperson develops a specialty, such as a market for trade-in machines that permits him or her to bid higher than competitors. Perhaps the salesperson was the first to introduce some successful new product in the market area (e.g., a four-wheel drive tractor of high horsepower), or developed an efficient adjustment of a commonly used item (e.g., a moldboard plow) that drew attention to his or her efforts. Periodic merchandising programs sponsored by the manufacturer attract special attention to individual items. Local promotions by the retailer, sometimes in cooperation with neighboring merchants, stir up interest.

Service

The "sales and service" phrase has become commonplace because the importance of service demands that attention. Experience in the sale of millions of mass-produced automobiles, television sets, washers, dryers, and similar items to the consumer market has proven the need for routine service plus "making good" on factory guarantees. Farm equipment differs from consumer products in that buyers consider them as production equipment. Each item must earn money for the owner. Usually farm equipment works in combination with other items. A tractor always pulls, pushes, carries, or drives something. A combine harvester requires grain wagons or trucks to work with it. A spring planting project may include two or more tractors, plus tillage machines, planters, chemical applicators, and trucks. Weather hazards and seasonal push require operators to schedule "round the clock" action quite often. Even a minor failure may stop all of the multiple-unit project. Downtime becomes extremely costly. A failure may be corrected by a replacement part at no charge, but if it causes delays of hours, days, or perhaps weeks, the owner suffers serious loss. Crop loss may exceed the value of the machine involved in some circumstances. The buyer's goal is "no down time." Retailer must work towards the same goal, backed up by the wholesalers and the factories that supply them.

Downtime problems can be reduced and controlled by efficient *retailers* and *retail salespeople* through wise preparation *before* the sale is made. This is accomplished by:

1. Understanding the soil and crops of the area and requirements as to power and equipment.
2. Choosing the product, brand, and product source based on experience in meeting local needs.
3. Knowing the capacities and capabilities of products so they are not oversold to the buyer.
4. Being familiar with and enthusiastic about distinctive features and characteristics of his or her major products. Factory representatives have explained these features at schools and meetings. In fact, the retailers may have requested the development of some of the new features during prior meetings.

5. Selling enough attachments to make the function of the machine complete (e.g.. including header control on a soybean combine at first, not after the user becomes irritated by the lack of it).
6. Selling enough accessories for adequate comfort and convenience (e.g., cab with air conditioning).
7. Stressing early selling and deliveries of seasonal items. This alleviates the problems of delayed or incomplete shipments, and allows for the accomplishment of pre-delivery service in an orderly manner.
8. Providing adequate parts stock, and following local experience and manufacturer's recommendations.
9. Training the shop foreman and his or her servicepersons by sending them to factory schools and meetings.

Downtime is further eliminated *after* the sale, when the *retailer's service department* is efficiently prepared to follow these procedures:

1. Performing predelivery service and tune-up according to the manuals. The latest service bulletins should be reviewed to utilize the most recent field experience by factory engineers and other users.
2. Making machine settings to anticipate the specific condition and first crop to be encountered.
3. Instructing the operator at or before delivery.
4. Making a friendly call-back a few working days after the sale of a complicated unit to clarify questions of the owner and operator.
5. Using a rapid ordering system for parts needed for emergencies.
6. Promptly carrying out terms of the manufacturer's guarantee.
7. Being familiar with the process of obtaining the maximum assistance from the manufacturer's service representative should a serious problem threaten to lead to the condemnation of the product.
8. Undertaking unusual emergency measures such as renting or loaning alternate equipment to support the customer in his or her urgent project.
9. Promptly carrying out factory-sponsored corrections to products under warranty, thus avoiding risk of more costly and irritating field breakdowns.

At the wholesale level, the efficient service department functions in support of the above procedures. It transmits useful information from the designer at the factory to the distribution people and to retailers. For each carefully designed product the factory departments prepare parts books, assembly and predelivery instructions, and operator's manuals, and subsequently issue needed service bulletins. In preparation for servicing a new model, the distributor's key service manager or technical representative usually attends a factory school to learn about any details of design or operation peculiar to the new model, and to acquire a general understanding of its relation to other products in the product line. This key person, in turn, conducts schools for retailers and often groups of users.

During the machine's season of use, a service representative for major manufacturers or wholesalers contacts retailers periodically to instruct and confer with service managers. Service reference information, special warranty programs, methods of adjustment, and repair or overhaul are among the subjects reviewed. Recent warranty reports are given extra attention.

Facilities

Efficient distribution by a retail store is often indicated by a broad display lot and parking area surrounding an inviting building. Such a business usually developed because its owners utilized modern management assistance from their major supplier, dealer associations, and perhaps business consultants. Some of this assistance would have included advice or help with:

1. Choice of store location.
2. Design and layout of the building.
3. Choosing equipment for the office, display area, parts department, and shop.
4. Maintaining continuing contracts with each important supplier.
5. Arrangements for proper financing for both inventory and retail sales.
6. Determining a balance of inventory.
7. Establishing an automatic inventory reordering for many items.

8. Computer processing of records.

9. Enterprise analysis for management decisions.

10. Regular development of merchandising programs.

11. Scheduling of advertising in support of planned programs.

12. Establishing personnel policies which are adequate and easily understood.

Innovations

Efficient retailers are meeting the changes in product distribution patterns in various ways. Service centers, including a shop and parts department are being established at separate additional locations by dealers. Another development is the satellite store arrangement based on a large "mother" store working with a number of smaller stores located in towns some distance away. Machinery auctions, held at regular intervals in trade centers, provide retailers with a source of used items in local demand and also provide a means of disposing of items which are unsalable in the normal trade territory. Improved communications and transportation methods are used by imaginative retail managers to improve services, to offer prompt factory delivery of special and complicated products, to keep posted about new products and new farm practices, and to meet new potential customers. Trade territories can now be larger.

Customers often operate large farms, ranches, plantations, and contracting businesses. These customers plan far ahead and respect the sales and service organization which is capable of servicing them. Those manufacturers, wholesalers, and retailers who team up in efficient distribution and service will merit continued respect and patronage by these customers.

The delivery of a machine is always a pleasurable event, but is seldom the end of the relationships among manufacturer, wholesaler, retailer, and customer. Such things as operating and maintenance instructions, warranty, credit accounts, parts and repair service, and market analysis data are necessary continuing elements to efficient equipment distribution. The individual who understands farm machinery mechanisms has a great career opportunity in equipment distributions.

INFORMATION SHEET #7

Retail Store Arrangement Principles

1. A suitable and attractive storefront.
2. Good signs to identify the business.
3. Clean, attractive store windows.
4. Easily accessible entrance.
5. Adequate illumination of displays and service shop.
6. Department identification to permit easy customer progress.
7. Use of light, color, and space to create the impression of size.
8. Arrangement of displays to stimulate sales.
9. Proper placement of parts and shop departments to facilitate customer service.
10. Accessibility of island and counter displays to invite self-service.
11. Avoidance of excessive visibility of shop operations, such as painting, cleaning, etc.
12. Modern shop facility to assure the customer of precision workmanship.
13. Prominent displays of parts to create customer confidence.
14. Loading platforms and ramps to reduce labor.
15. Elimination of hazards that promote a safe environment for customers and employees.
16. Judicious but proper use of posters, placards, etc.
17. Customer conveniences, such as telephones, lavatories, and toilets.
18. Adequate parking facilities to meet changing conditions.
19. Arrangement of departments to meet peak season loads.
20. Conformance, in general, to habits of customers.

INFORMATION SHEET #8

Designing Agricultural Equipment

An integral part of the equipment manufacturing process is the design stage. Agricultural engineers have to take into consideration many factors when designing new equipment. Each component needs to be carefully designed so that it will function properly when in the hands of the customer. Also, cost to manufacturers, operator's safety, consumer appeal, and a host of other factors are considered during the design process. One of these factors is the human factor.

The following information in this information sheet is adapted from *The Human Factor in Farm and Industrial Equipment Design* by William F. H. Purcell (see reference list).

Human Factors Engineering means engineering the product to fit the user rather than the other way round! It requires knowledge of anthropometry, biology, biomechanics, physiology, and behavioral psychology, and access to research on human reaction to machines, to products, and to other people.

Anthropometry

Anthropometry is the study of the human body, of the dimensions of large, average, and small men and women and the limits of their body movements and strength. In designing machines which people can operate comfortably, efficiently, and safely one needs to know their physical structure, as well as the range of their emotional responses, their comfort, and their prejudices. We now have good anthropometrical data gathered from surveys made since the second World War and from research materials produced in universities and governmental agencies in many countries.

The rate of height increase in the United States is of interest to designers of long-lasting equipment. For the average man or woman height has increased approximately 10 mm in each decade since 1040. It is predicted that height will stabilize at about 178.8 cm for the average adult male toward the end of the century. The female then will reach an average height of 165.1 cm. However, predictions of this sort can change radically depending on world events. It is interesting to look back in time by visiting museums with collections of old suits of armour and noting how short the knights of the 15th and 16th century were!

There are also notable differences in the proportions of the body between races. We do not have much data on these differences except in the case of the Japanese, who have been quite active in the field of Human Factors. We have had to modify Japanese tractors on which the seat had to be set at a maximum rearward position to operate the foot controls, which in turn put the steering wheel too far (85mm) away for comfort.

The average U.S. white male and his Japanese counterpart have the same average trunk dimensions, i.e., the seated bodies are about equal in height and the eye positions would be coincident. However, the U.S. white male has a 50 mm longer reach than the Japanese and an 85 mm longer leg measured from the back of the buttock to the foot. The average U.S. black male is shorter than the U.S. or Japanese male in the seated position, but has a 15 mm and a 65 mm longer reach than the average U.S. and Japanese male respectively. The outstanding difference comes in the leg dimensions where the Japanese male is 128 mm shorter and the U.S. white male 38 mm shorter than the U.S. black male.

Besides the information on people of average proportions for their height, we have to consider the three main body types, the "rotund" (endomorphic), the "muscular" (mesomorphic) and the "thin" (ectomorphic). It is important when modifying designs to include the rotund types in clearance that is allowed for thighs and abdomen and still keep controls and steering within reach. Usually this has to be done by making steering wheels and seats adjustable.

The age of the operators of farm equipment is most important because the average age of farmers in the U.S. has been rising continuously since the beginning of the century. In 1978, 47 percent of the U.S. farm population (14 years and over) were 45 years of age or over, and about one third of this group were 65 years of age or over. Some of the effects of aging are as follows:

1. Standing height decreases as a result of increasing compression of the fibrous discs separating the vertebrae.
2. Muscular strength falls off; at the age of 60 a person has about 80 percent of the strength he or she had at age 30 (Van Cott and Kinkade, 1972).
3. Reach decreases by 25 mm (average).
4. Discomfort in heat and cold tends to increase.
5. There is an increased fear of falling.
6. By age 60, vision over a distance decreases in sharpness. Minimum close focal distance (uncorrected) is as much as 1000 mm.

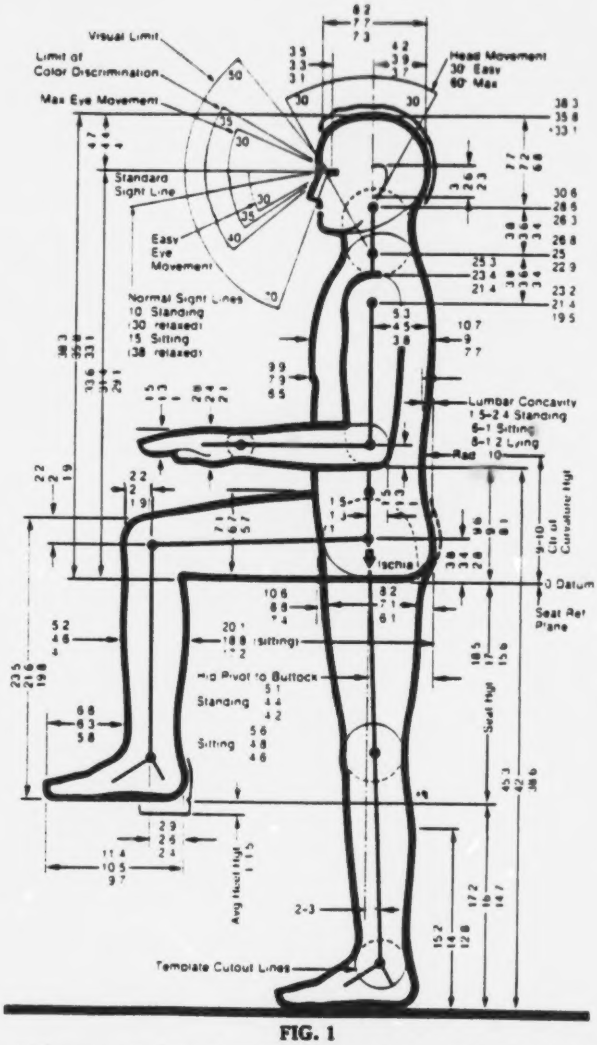

Visual Limit
Limit of Color Discrimination
Max Eye Movement
Head Movement 30° Easy 60° Max
Standard Sight Line
Easy Eye Movement
Normal Sight Lines 10 Standing (30 relaxed) 15 Sitting (38 relaxed)
Lumbar Concavity 1.5-2.4 Standing .6-1 Sitting .8-1.2 Lying
Rad 10
Ctr of Curvature Hgt
Ischial
0 Datum
Seat Ref Plane
Hip Pivot to Buttock
Standing 5.1 4.4 4.2
Sitting 5.6 4.8 4.6
(sitting)
Seat Hgt
Avg Heel Hgt 1-1.5
2-3
Template Cutout Lines

FIG. 1

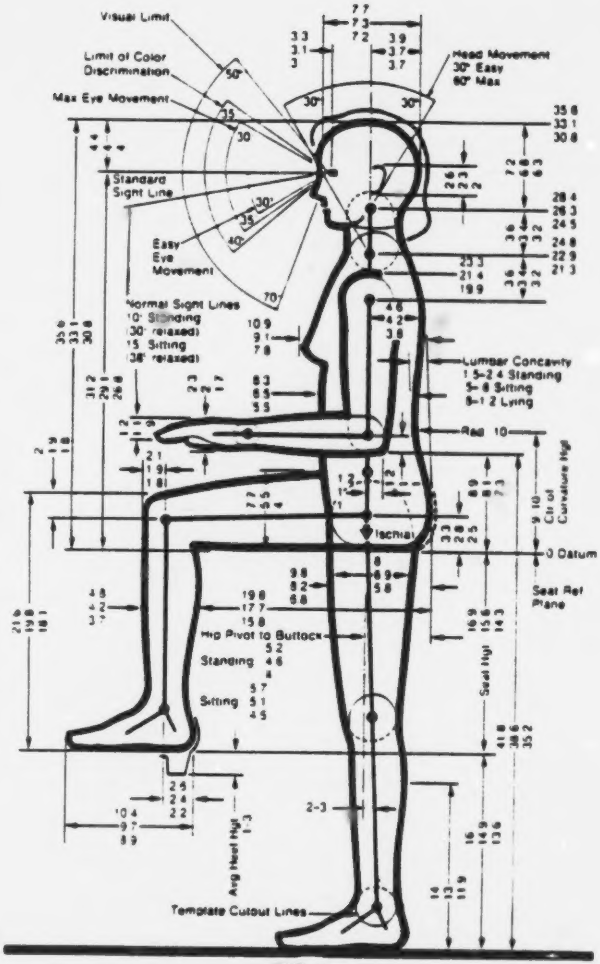
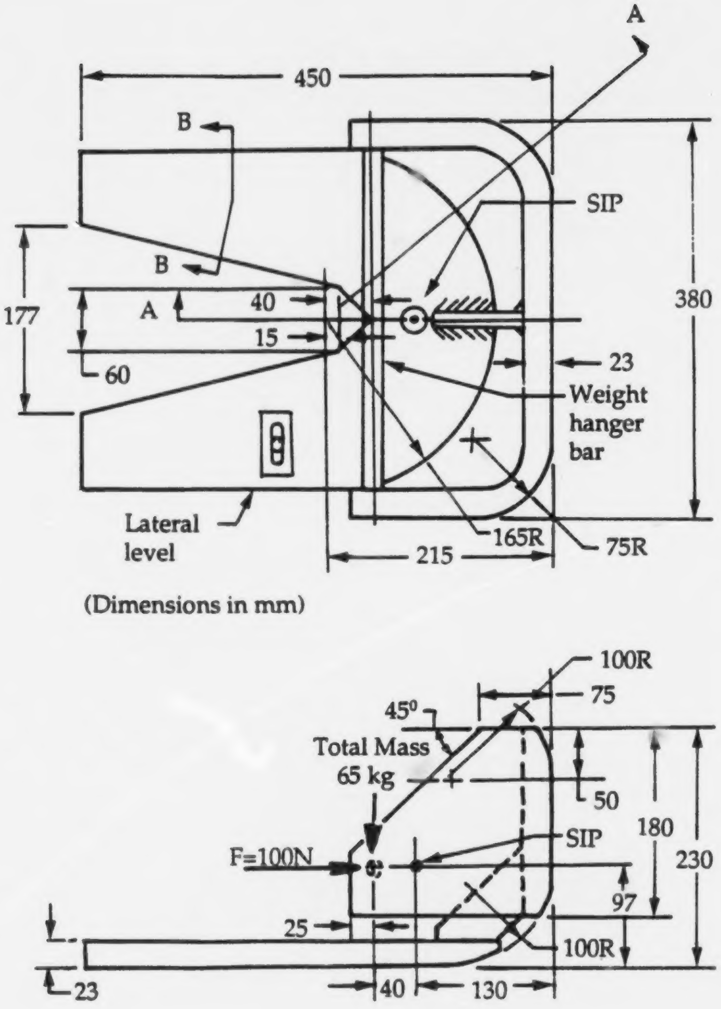

Visual Limit
Limit of Color Discrimination
Max Eye Movement
Head Movement 30° Easy 60° Max
Standard Sight Line
Easy Eye Movement
Normal Sight Lines 10° Standing (30° relaxed) 15 Sitting (38° relaxed)
Lumbar Concavity 1.5-2.4 Standing .5-.8 Sitting .8-1.2 Lying
Rad 10
Ctr of Curvature Hgt
Ischial
0 Datum
Seat Ref Plane
Hip Pivot to Buttock
Standing 5.2 4.6 4
Sitting 5.7 5.1 4.5
Seat Hgt
Avg Heel Hgt 1-3
2-3
Template Cutout Lines

FIG. 2

Anthropometric charts of standing and seated males and females. Measurements shown are of 2.5, 50 and 97.5 percentile U.S. males and females. Dims: inches.


A
450
B
SIP
B
380
177
A
40
15
60
23
Weight hanger bar
Lateral level
165R
75R
215
(Dimensions in mm)
100R
75
45⁰
Total Mass 65 kg
50
SIP
180
230
F=100N
97
25
100R
23
40
130

SAE seat index point measuring device.

7. Ability to see in low levels of illumination is reduced.

8. Hearing acuity drops significantly. This is a natural process that has been hastened by many years of driving farm tractors without the benefit of today's noise attenuation systems and enclosed cabs.

The greater experience of the elderly operators undoubtedly overcomes some of the disadvantages of age. This, combined with the increase in the recorded knowledge of human factors, should produce vehicles as safe and convenient for the elderly as for the young.

Seating

There are a number of specific areas where knowledge of human factors is of prime importance. Seating is the first. It can be the cause of the greatest fatigue and discomfort to an operator, or the greatest relief and comfort, depending on how much medical knowledge and practical operating convenience the seat designers have incorporated. Statistics indicate that over 50 percent of adults suffer from backache at least once in their lives (Grandjean et al. 1973).

It has been proven that where a real improvement in the comfort of a new seat design has been introduced on the market, it has been a successful product even though a considerable increase in the cost had to be added. Obviously, we have come a long way since the old "plow" seat was standard for the industry, but the real breakthrough in seat design did not come until the best medical knowledge was applied to the problem.

Entry and Egress

Entry and egress is a subject often neglected by designers in the past, but today competition demands greater convenience for the operator and improved safety standards, backed by the threat of negligence suits against designers and manufacturers. There has long been a compromise between designing a tractor for good crop clearance and good access, but these new standards are making designers hold the line on crop clearance and be more imaginative in the solution of the human factors requirements. As a designer, you may better satisfy the standards of safety and convenience if you think of yourself as being over 65 years of age, probably wearing bifocals, and being slightly arthritic.

The height of the first step above ground is of prime importance. ASAE Standard shows 686 mm maximum and 550 mm preferred; 535 mm should be considered a maximum for any new vehicle design, with 300 mm maximum between steps. Steps requiring a decision as to which foot to start up with should not be used, and all steps should be a minimum of 380 mm width to allow room for both feet. It should be noted that these suggested limits are based on safety and convenience during descent rather than ascent; descent is by far the more dangerous operation. Grab rails which give continuous support from the moment the operator's second foot leaves the ground to the time he or she stands on the platform, or top step, should be provided. The grab rails should be rounded in section and from 20 to 30 mm in diameter, depending on the length. They should always be closed or curved under at the ends so that the hand cannot slip off the end of the rail without a warning; usually this would occur only when an operator descends facing backwards. The safety of ladders varies inversely with their steepness, because the center of gravity of the body falls outside of the foot support, causing the arms to take the extra horizontal component of force to prevent falling. In the case of a vertical ladder, the critical moment is when taking the first step down from the top to a blind step. It is not only that one can't be sure of how wide the step is, or whether it is a single or a double step, but also how far down it is; misjudgments in either case cause serious accidents. It is of great importance that sufficient slope be given so that the operator can see with a glance downward what confronts him; also, that the handrails or hand holds provided are positioned to allow the person to descend with an extended arm so that, if a slip occurs, motion can be stopped before too much momentum of the body is developed. This also helps to keep the center of gravity of the body more over the foot supports.

Any ladder which has a flatter slope than 70 degrees (more than 20 degrees from the vertical) should be closed in the back of the treads to prevent the foot and leg slipping through between the steps; the flatter the slope in this case, the greater the hazard. The treads should be 178 mm minimum in depth. The safety backing should also be provided when any moving parts can be contacted by the feet when on the ladder.

If a platform is used, as it is on combines, the outer edge must be protected by a guard rail of 900 to 1050 mm height with one intermediate rail.

Lastly, we should emphasize the need for providing a nonskid surface on all vehicle steps which remains effective in all weather conditions. A step which compresses the mud through openings in the step surface and allows the foot to keep full contact on the nonskid patterned area is probably the best solution; however, it is necessary that the nonskid pattern be omni-directional. Some areas, especially Northern Europe and Sweden, have such severe mud conditions that is advisable to add a mud scraper either as a lower step, or as an option attached to the side of the lower step where most of the mud can be taken off before mounting into the cab.

Controls

There are many interfaces between man and his machine. They include actions such as getting in and out; daily maintenance such as cleaning, servicing, and refueling; riding in or on the vehicle; and operating the controls for performing the needed tasks. All these interfaces react on the owners or operators to produce a level of confidence and satisfaction which may or may not please them. Controls rate the highest of all the above interfaces in their potential to give satisfaction except, of course, the actual functioning and efficiency of the machine. The operator feels and senses the responses of the power, efficiency, and quality of the machine through manipulation of the controls. The degree of operator fatigue and safety during operation on difficult terrain are directly related to the effectiveness of the controls.

The resulting design solutions for different types of machines such as tractors, cotton pickers, or combines, necessarily differ widely because of the different functional priorities reserved for each type, particularly in the visibility requirements.

Because the seat must be properly related to the controls, it is the first item to be located. The seat must be placed to give the operator an optimum field of vision and also be in a position on the vehicle which helps give the operator a comfortable, secure ride under most operating conditions. There must also be space around the seat for the controls to be placed in a logical and orderly fashion.

Appearance

The importance of a good appearance in both farm and industrial equipment has been increasing steadily for the past 40 years. It fits into the historic pattern of most manufactured products: first, the invention stage when the product's usefulness is accepted as the only important criterion; second, when the product faces competition in its field and the rate of technical advances reaches a plateau; finally, when aesthetic appeal as well as human factors become essential sales factors. Today the appearance of farm equipment has reached this stage — a farmer expects an attractive appearance in a tractor or combine almost as much as in an automobile — and this in turn raises expectations for good-looking equipment all the way down to plows, harrows and planters!

Good Design

1. Good design expresses a product's function and purpose. The product should look as though it could perform its task easily, safely, and efficiently. This is done by developing handsome and appropriate forms for the product, well proportioned and in good scale for the work it does.

2. Good design expresses and emphasizes the quality put into the product by engineers. This is achieved by development of good detail. Joints are of prime importance; so, also, are attachment details, brackets, steps, handrails, interiors, knobs, controls, and, of course, the final quality of the surface finish.

3. Good design makes evident the elements of safety and ease of operation that have been designed into the product. This means designing good entry and exit systems and easy access for maintenance, with well-detailed safety items such as grab bars, steps, and safety signs. It also means designing for good visibility from the operator's position and for well-placed controls with clear instructions. Above all, the product should be given an uncluttered look both inside and out.

Appearance design in this field of farm equipment is not some magic or arbitrary clothing of the product which can be applied to the engineer's design after all the necessary testing has been completed. It is called Industrial Design because it does have to satisfy the three requirements outlined above, and it necessitates the closest cooperation between product design engineers, production engineers, marketing people, and industrial designers. In the early years, industrial designers were brought in toward the end of the product's development cycle — even after most of the testing program had been completed. This resulted in inadequate attention to appearance or in a more costly program which involved engineering changes or undesirable cover-up design. Today, a successful product design requires that engineers work with industrial designers as soon as the engineering concept has progressed to the point where it can be generally described; certainly well before any engineering layouts are completed for prototypes. From this point on, development must be a close partnership involving frequent meetings through the various design phases, with models, mock-ups, prototypes and drawings used to ensure clear communication between all groups.

Visual Perception and Instrumentation

The importance of providing the operator of farm vehicles with adequate information on the task being performed or on the condition of the vehicle itself has increased dramatically during the last few years. Monitors for planting operations, fuel efficiencies, and the usual engine and transmission functions are all competing for space within the operator's cone of vision.

The reasons for this are primarily the large increase in the capital cost of equipment and the accompanying high cost of maintenance which has followed the steady increase in power and size of the vehicle. The larger machines are desired to offset the inflated costs of fuel, seed, and fertilizer by reduced labor and time costs.

Another reason for providing monitors, unrelated to costs, has been the trend toward improvement of the operator's environment by providing air-conditioned, sound proofed cabs that isolate the operator from all the warning sounds of the engine, transmission, or attached equipment which was previously relied upon to prevent costly breakdowns. In earlier days, with an open operator station, the operator could also feel and sense the efficiency of the operation in the field. To provide this additional information without getting the operator unduly confused, designers must rely on better human factors to back up the new technology of today and to improve the old. The senses left to the operator in the sealed-up cab are mainly visual and to a lesser extent, auditory; therefore, a brief summary of the known limits of visual perception should be given.

Important parameters for ensuring easy and accurate reading of the instruments are discussed below.

1. Letters and numerals must be adequately sized. They must be sized to give easy reading at the panel distance of 700 mm. The letters should be a minimum of 5 mm high. This height is derived from a rule of thumb for letter sizing with respect to distance; namely that for every 1000 units of viewing distance, letters should be 7 units high. It should be doubled or tripled if data is critical or illumination is inadequate.
2. Pointers should be simple in shape. Visually, they should be the most prominent objects on the dials; and they should match the color of the indices.
3. Zones should be used to mark danger levels on the dials, preferably in red. If a normal working range needs emphasis, it should be coded green.
4. The size of the dial faces should be set by the spacing of the scale markings required to give sufficiently accurate readings.

In recent years, the search for a better system of monitoring the vehicle, and the task performed by it (better than the standard system which uses analog instruments), has led to some interesting developments with multisensing, solid state computer circuits with Liquid Crystal Displays (LCDs). This system has almost unlimited potential for monitoring any function on the vehicle or on the implement, giving qualitative as well as quantitative information. Its use is limited by the cost, which depends largely on the number of sensors used.

Another limitation is the space required on the control panel for LCD readout, which requires a separate area on the panel for each message displayed.

Priority Factors Used for the Layout of Panel Gauges and Lights

Gauges	Priority Factors				Existing Standards and Recommendations for New Standards
	Emergency Safety	Frequency of Use	Accuracy of Readout	Grouping - By Function or Type of Display (Gauge or Light)	
Tachometer and/or Speedometer	Depends on Vehicle	Depends on Vehicle	High	Group Tachometer and Speedometer together if separate units are used	Locate at or to the right of center of panel to act as visual divider of gauge groups and as reference point
Engine Water Temperature	High	High	Medium	Group together as a horizontally read pair	(1) Group Temperature and Pressure gauges together in that order in each horizontally read Engine and Transmission gauge pair (SAE recommendation) (2) Locate Engine group on left side of panel center and Transmission group on right (SAE recommendation) (3) If an indicator light is substituted for one or both gauges in a pair, locate it in the same relative location of the gauge it replaces
Engine Oil Pressure	High	High	Medium		
Transmission Oil Temperature	High	High	Medium	Group together as a horizontally read pair	
Transmission Oil Pressure	High	High	Medium		
Fuel	Medium	Medium	Medium	Group Fuel and Voltmeter or Ammeter together in that order as a horiz. read gauge (and/or indicator light) pair	Locate pair below or to left of Engine gauge pair
Voltmeter or Ammeter	Medium	Medium	Medium		
Brake Pressure or Other Special Gauge	High	High	Medium		Locate in high priority optional gauge location
Hourmeter	Low	Low	High		Locate in lowest priority optional gauge location used

Lights					
Indicator Lights in Place of Gauges	High	Low	Low		Locate in place of gauge it replaces closing up space where possible; color code
Park Brake Indicator	High	Low	Low	Group with (near) Park Brake control	Locate above or adjacent to Park Brake control but do not locate off panel; color code red
Turn Signal Indicator	High	Low	Low	Group these lights together at center of panel to act as visual panel divider, whether Tach is used or not	Arrange left and right indicator to be read on a line transverse to vehicle; color code green
High Beam Indicator	High	Low	Low		Color code blue
Other Indicators	High	Low	Low		Arrange in an orderly manner; color code

Priority Factors Used for the Layout of Instrument Panel Controls

Panel Controls	Priority Factors				Existing Standards and Recommendations for New Standards
	Emergency Safety	Frequency of Use	Accuracy of Readout	Grouping - By Function or Type of Control	
Key Switch or Key Switch Start-Stop	High	Low	Low	Group these engine start/stop functions together in the order listed	Locate Key Switch on right side of panel; key Switch is a major reference point on panel to which Horn (if not Stalk mounted) and other engine Start/Stop controls are related
Start Button	High	Low	Low		Locate Engine Start on Key Switch (preferred); locate directly to right of key switch; color code red
Engine Stop Knob	High	Low	Low		Locate Engine Stop in Key Switch (preferred); locate directly to right of Key and Start button; color code red
Choke Knob	High	Low	Low		Locate in place of stop knob
Start Aid Button	High	Low	Low		Locate on left side of front mounted panel, separate from A and B to avoid overcharge; allow space between it and other controls to avoid accidental operation; code yellow
Horn Button	High	Low	Low		Locate on steering wheel stalk (preferred); locate directly to left of Key Switch; color code black
Turn Signal Lever	High	Low	Low	Group these light functions together unless turn signal lever is on stick; if separate light switches are used group them together in a row	Locate on steering wheel Stalk (preferred); locate on far left of panel
Light Switch(es) (road, work, and warning lights)	High	Low	Medium		Locate to right of turn signal lever or on far left of panel if turn signal is on stalk; locate separate warning, or other auxiliary light switch (es) to right of main light switch
Wiper Switch	High	Low	Low		Locate on left side of front mounted panel; locate to right of light switch
Park Brake Release	High	Low	Low		Locate on left side of front mounted panel above or adjacent to Park Brake control
Lighter	High	Low	Low		Locate on right side of front mounted panel; locate to right of start aid button to separate it from other controls
Steering Wheel Control Stalk Incorporating: Horn, Turn Signal Lever, Head Light, and Dimmer	High	Low	Medium		Locate on left side under steering wheel

INFORMATION SHEET #9

Other Sources of Infomation

1. Farm and Industrial Equipment Institute
   410 North Michigan Avenue
   Chicago, IL 60611-4251
   (312) 321-1480

2. Illinois Retail Farm Equipment Association
   3500 N.E. Adams Street
   P.O. Box 1227
   Peoria, IL 61654
   (309) 688-6676

3. The North American Equipment Dealers Association
   10877 Watson Road
   St. Louis, MO 63127-1081
   (314) 821-7220

4. Farm Management Wholesalers Association
   1927 Keokuk Street
   P.O. Box 1347
   Iowa City, IA 52240
   (319) 354-5156

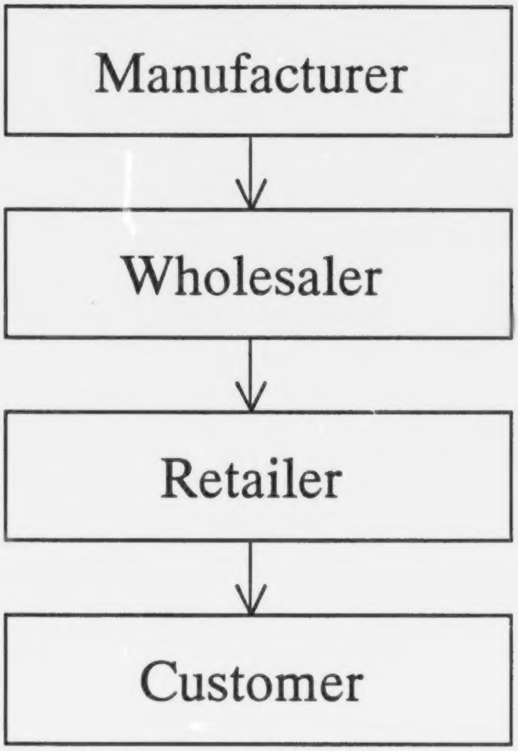
5. American Society of Agricultural Engineers
   2950 Niles Road
   St. Joseph, MI 49085-9659
   (616) 429-0300

6. Agricultural and Industrial Manufacturers Representatives Association
   5845 Horton Street
   Suite 201
   Shawnee Mission, KS 66206
   (913) 262-4511

7. Farm Equipment Manufacturers Association
   243 N. Lindbergh Blvd
   St. Louis, MO 63141
   (314) 991-0702

TRANSPARENCY MASTER #1

Distribution of Agricultural Equipment



Manufacturer

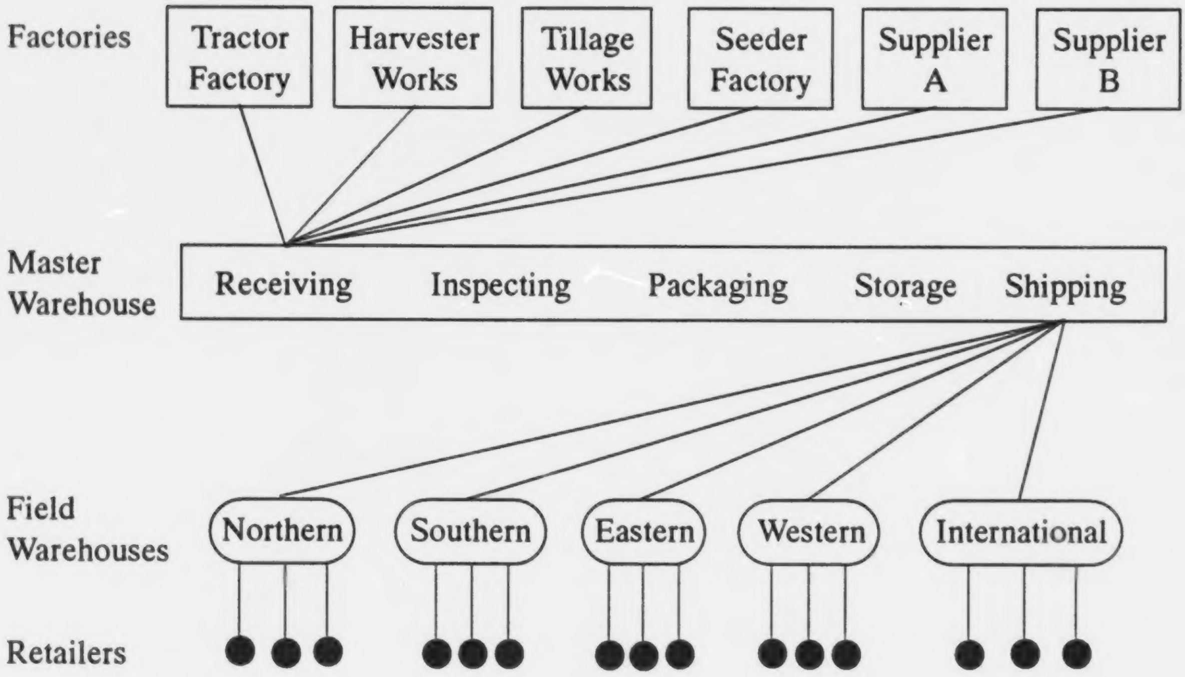
Wholesaler

Retailer

Customer

TRANSPARENCY MASTER #2

Agricultural Equipment Product Flow (Manufacturing through Distribution)


Factories
Tractor Factory
Harvester Works
Tillage Works
Seeder Factory
Supplier A
Supplier B
Master Warehouse
Receiving
Inspecting
Packaging
Storage
Shipping
Field Warehouses
Northern
Southern
Eastern
Western
International
Retailers

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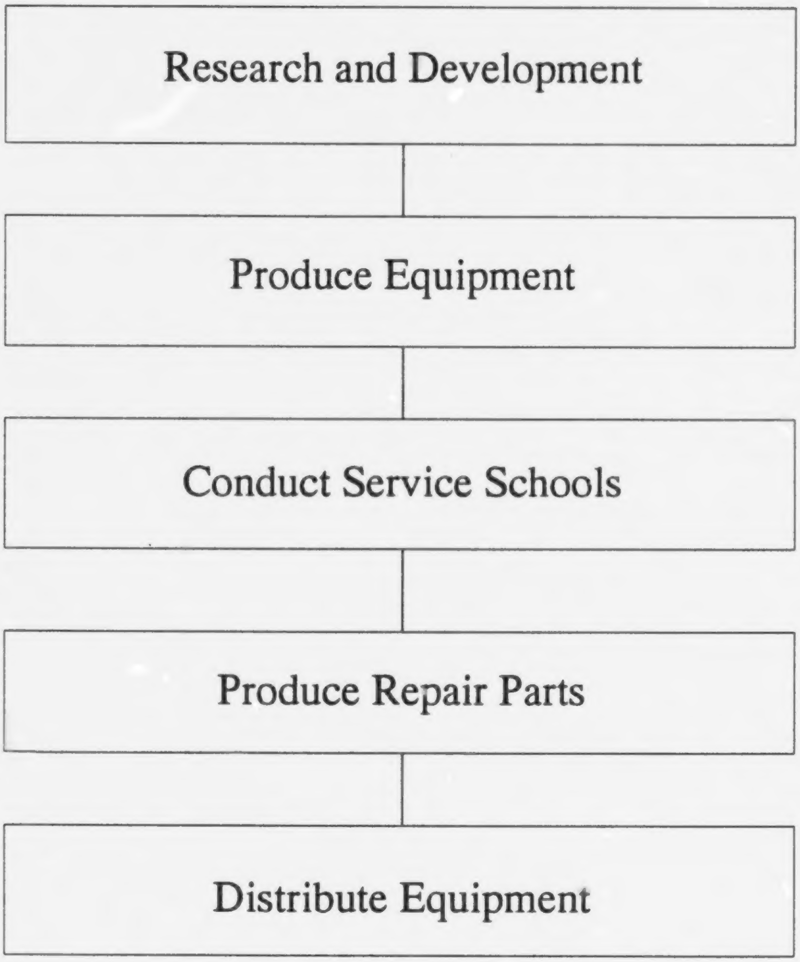
TRANSPARENCY MASTER #3

Functions of the Machinery Manufacturer



Research and Development

Produce Equipment

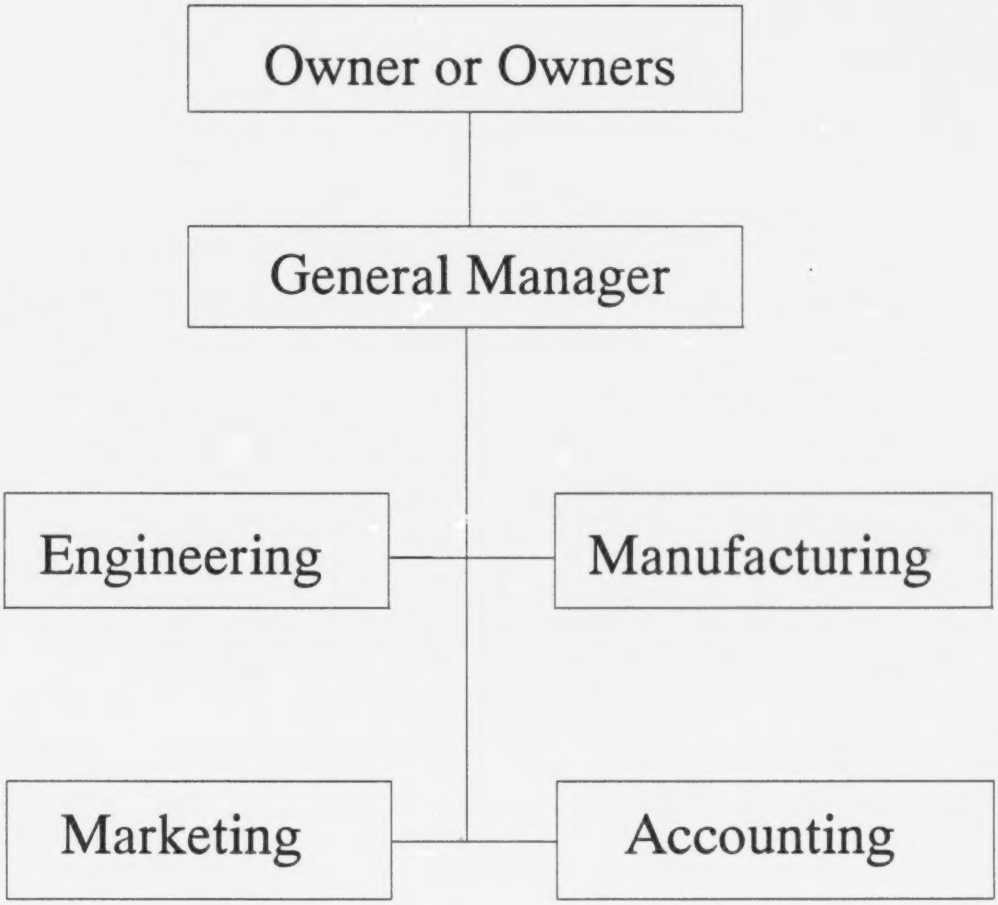
Conduct Service Schools

Produce Repair Parts

Distribute Equipment

TRANSPARENCY MASTER #4

A Manufacturer's Minimal Organization



Owner or Owners

General Manager

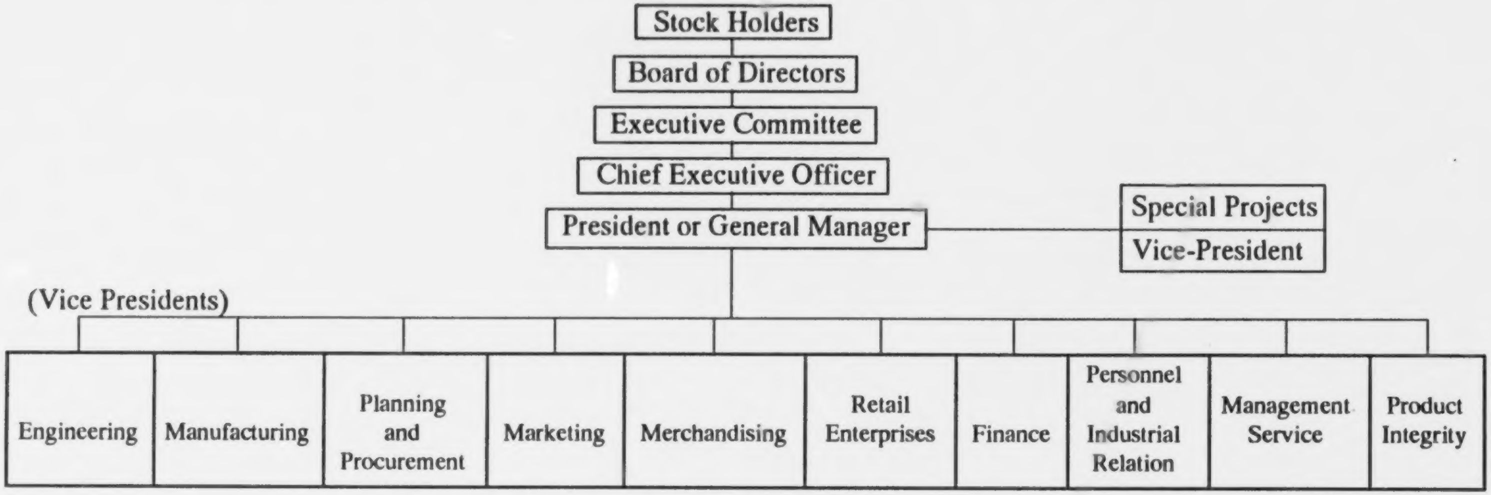
Engineering

Manufacturing

Marketing

Accounting

Typical Organization for Large Farm Machinery Maufacturing Corporations



Stock Holders

Board of Directors

Executive Committee

Chief Executive Officer

President or General Manager

Special Projects Vice-President

(Vice Presidents)

Engineering	Manufacturing	Planning and Procurement	Marketing	Merchandising	Retail Enterprises	Finance	Personnel and Industrial Relation	Management Service	Product Integrity
Product Engineering	Industrial Engineering	Purchasing	Sales	Merchandising	Stores	Treasurer	Employ.	Commun.	Projects and Systems
Drafting	Production	Traffic	Product Distrib.	Sales Promotion	Retail Develop.	Account.	Payroll	Procedures & Forms Control	Product Integrity Managers (Service)
Administr.	Factory Manager	Transport	Marketing Plans	Advertising	Admin. Manager	Financial Reporting	Employee Resourcing	Plans and Control	
Shop	Quality Control	Program Planning	Product Mgt. & Planning	Public Relations	Dealer Develop.	Financial Analysis	Employee Develop.	Business Systems	
Laboratory	Purchasing	Inventory Control	Market Research	Training		Tax	Employee Benefits	Tape-Library	
Field Test		Parts	Economic Research			Customs	Labor Contracts	Electronic Data Processing Operations	
		Whole Goods Supply				Financial Systems		Training & Standards	
		Warehouse				Properties			

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TRANSPARENCY MASTER #5

TRANSPARENCY MASTER #6

Functions of Machinery Wholesalers and Branch Houses

- Storage
- Financing
- Sales and Distribution
- Protection of Market
- Advice on Market Conditions
- Selection of Retail Agencies
- Providing Lower Handling and Transportation Costs
- Simplification of Credit

TRANSPARENCY MASTER #7

Functions of the Machinery Retailer

- Stock Suitable Machinery
- Sell Vigorously
- Service Equipment
- Supply Parts
- Arrange Financing
- Advise Farmers
- Provide Manufacturing Feedback

TRANSPARENCY MASTER #8

Typical Areas Found at an Agricultural Equipment Dealership

Primary Areas in the Main Building

1. Sales
2. Parts
3. Service
4. Management

Secondary Areas

1. Customer Parking
2. Receiving (Loading/Unloading, Docks)
3. Equipment Displays
4. Diesel Fuel System Service Room
5. Machinery and Equipment Storage
6. Restrooms and Lockers
7. Coffee Break Room
8. Painting and Washing

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TRANSPARENCY MASTER #9

Building Location and Other Factors

Considerations when selecting the building and its location:

- To serve the customer better
- To facilitate the operations of the business
- To make a profit

Location:

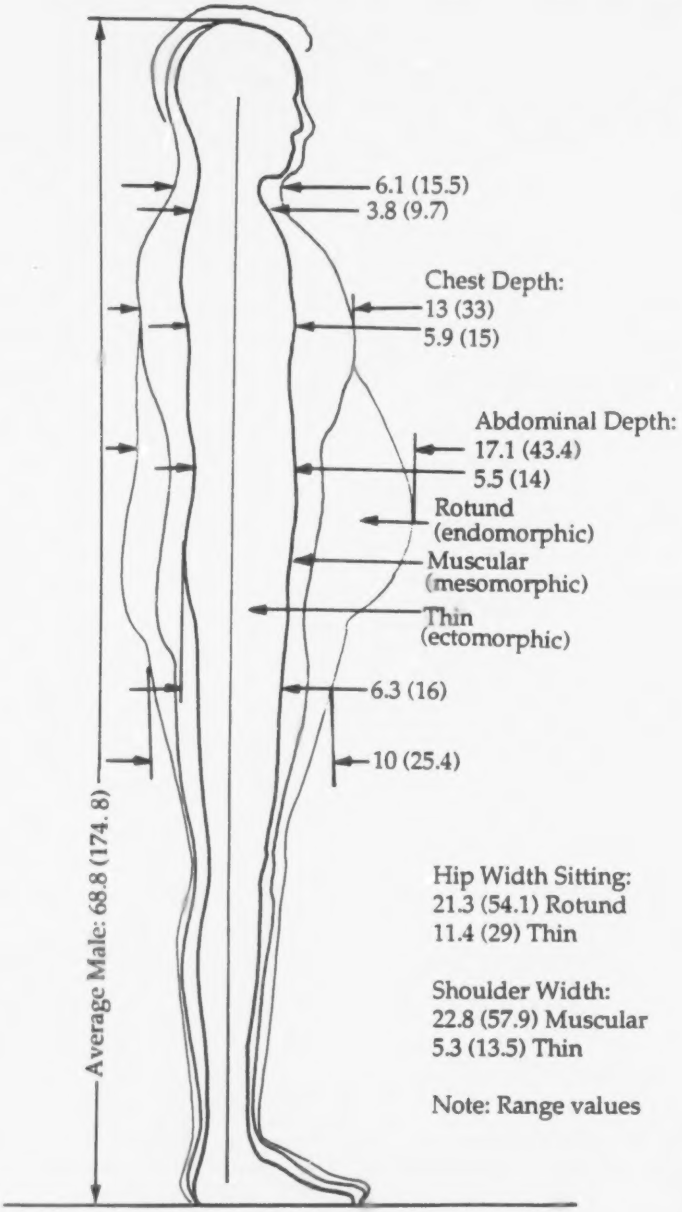
- Urban versus rural
- Traffic/accessibility
- Proximity of competitors
- Ease of shipping and receiving machinery
- Convenient for employees
- Near bulk shipping terminals
- Zoning considerations
- Utilities

Size:

- The 1980 avg. site size was about 60,000 square feet (1.5 acres)
- Three to five acres is desirable
- Rectangular shape with 300 foot frontage

TRANSPARENCY MASTER #10

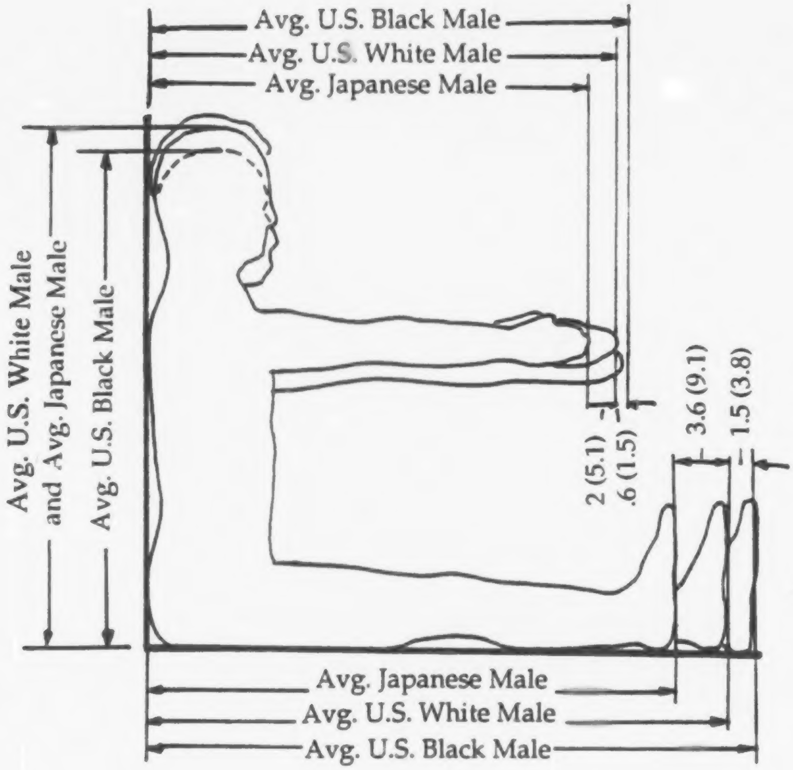
Three Basic Human Body Types


6.1 (15.5)
3.8 (9.7)
Chest Depth:
13 (33)
5.9 (15)
Abdominal Depth:
17.1 (43.4)
5.5 (14)
Rotund (endomorphic)
Muscular (mesomorphic)
Thin (ectomorphic)
6.3 (16)
10 (25.4)
Average Male: 68.8 (174.8)
Hip Width Sitting:
21.3 (54.1) Rotund
11.4 (29) Thin
Shoulder Width:
22.8 (57.9) Muscular
5.3 (13.5) Thin
Note: Range values

Dims: Inches (cm)

TRANSPARENCY MASTER #11

Proportional Differences in Races

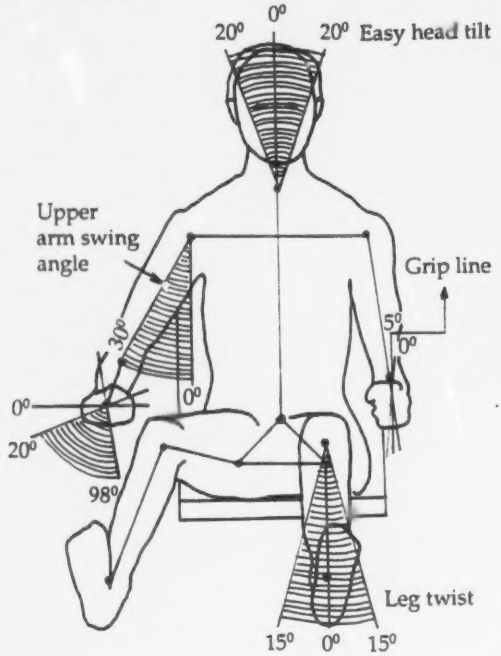

Avg. U.S. Black Male
Avg. U.S. White Male
Avg. Japanese Male
Avg. U.S. White Male and Avg. Japanese Male
Avg. U.S. Black Male
2 (5.1)
.6 (1.5)
3.6 (9.1)
1.5 (3.8)
Avg. Japanese Male
Avg. U.S. White Male
Avg. U.S. Black Male

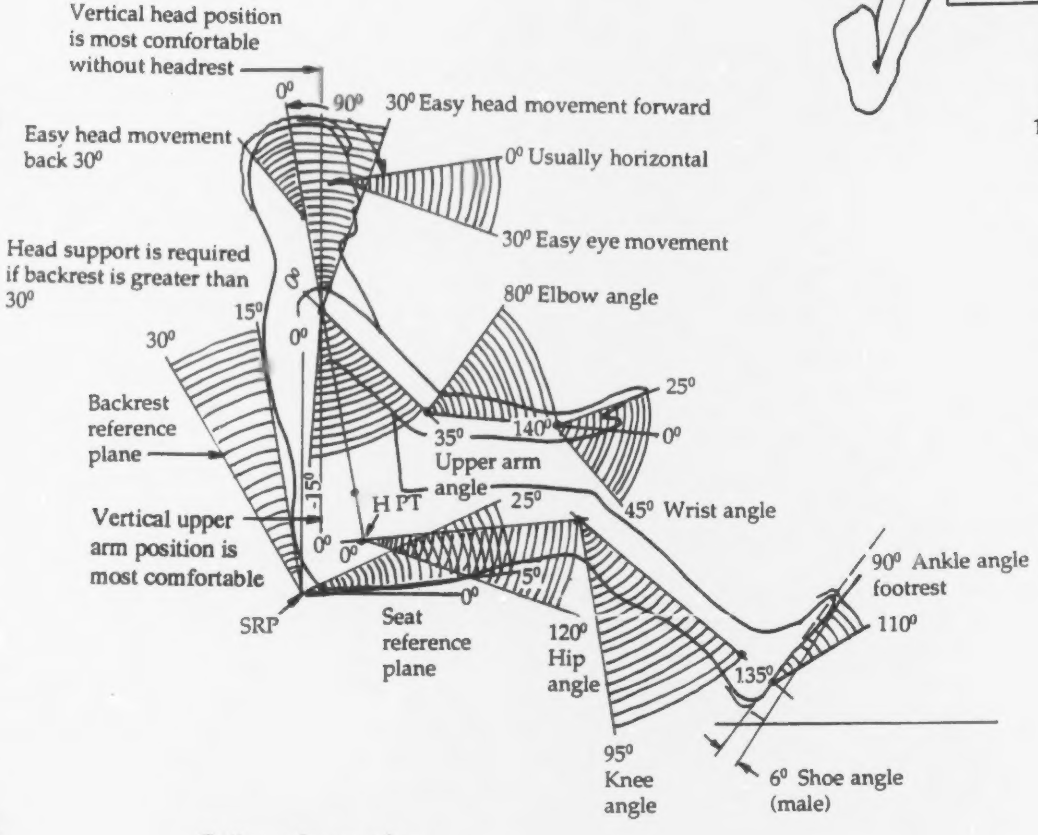
Dims: Inches (cm)

TRANSPARENCY MASTER #12

Angles of Comfort for Vehicular Seating

(Comfort Zones Are Shaded)


20°
0°
20° Easy head tilt
Upper arm swing angle
Grip line
5°
0°
30°
0°
0°
20°
98°
Leg twist
15°
0°
15°


Vertical head position is most comfortable without headrest
0°
90°
30° Easy head movement forward
Easy head movement back 30°
0° Usually horizontal
30° Easy eye movement
Head support is required if backrest is greater than 30°
80° Elbow angle
0°
15°
30°
0°
Backrest reference plane
25°
35°
140°
0°
Upper arm angle
-15°
H PT
25°
45° Wrist angle
Vertical upper arm position is most comfortable
0°
0°
15°
0°
90° Ankle angle footrest
SRP
Seat reference plane
120° Hip angle
110°
135°
95° Knee angle
6° Shoe angle (male)

Optimum knee angles:	
Relaxed	105-110°
Normal forces on pedals	110-120°
Heavy forces on pedals	135-155°

TRANSPARENCY MASTER DISCUSSION GUIDE

Transparency Master #3

1. Research and Development — A great deal of coordination is required with many agencies. Manufacturers must keep current with farming trends and practices. They must maintain liaison with universities and other public agencies doing research in agriculture and agricultural machinery. Also, they must remain current in manufacturing techniques and materials.

2. Produce Equipment — Manufacturing facilities and techniques must be kept modern. Quality control must be ever-active to see that equipment that leaves the retailers' shelves can perform its intended function.

3. Conduct Service Schools — Though the retailer has the responsibility of maintaining and servicing the equipment, the manufacturer must conduct training schools for the mechanics to introduce them to the new machinery being produced.

4. Produce Repair Parts — Manufacturers must produce the parts necessary to service their equipment over its lifetime.

5. Distribute Equipment — Machinery and parts must be distributed to branch houses and wholesalers around the trade area. This entails a transportation function.

Transparency Master #6

The branch house is an arm of the manufacturer. It differs from the wholesaler not in function, but in the fact that the wholesaler may and usually does represent several manufacturers. The functions of machinery wholesalers and branch houses are:

1. Storage — Wholesalers provide storage space for the manufacturer. They buy and store goods at the time they are produced and hold them until they are needed by local retailers.

2. Financing — By buying and paying promptly for goods as they are produced, the wholesaler lessens substantially the amount of capital needed by the manufacturer.

3. Sales and Distribution — Through the wholesaler and branch house the factory can get national distribution more quickly and more thoroughly than by any other means.

4. Protection of Market — If there were no wholesalers, small- and medium-sized independent retailers would constitute, at best, only a minor factor in the marketing scheme. No manufacturer would be able to enjoy sufficient coverage without selling through corporate chains, mail order houses, and cooperatives.

5. Advice on Market Conditions — The wholesaler or branch house keeps the manufacturer advised on market conditions, the nature of goods which can most readily be sold in the market, the type of product which farmers seem to prefer, and the size of the unit which has the greatest appeal.

6. Selection of Retail Agencies — A manufacturer desires to be represented by the best retailer in an area. Wholesalers, through their salespeople, know intimately the operations, character, and financial resources of the retailers in their trade area.

7. Providing Lower Handling and Transportation Costs — By ordering goods in car lots the wholesaler not only lowers the distribution costs of the manufacturer, but also contributes to lower costs to retailers and consumers.

8. Simplification of Credit — If it were not for the wholesaler, there would have to be credit checks by several hundred manufacturers on each of their retailers.

Transparency Master #7

1. Stock Suitable Machinery — The local dealer shoulders the responsibility of what to stock. A basic function is to offer for sale in a community that equipment which will help producers to prosper. It must be on hand in the quantity and quality needed at a price farmers can afford to pay.

2. Sell Vigorously — Retailers must fulfill the needs of the customers as well as their wants. Needs are economic. Wants are desires, such as the desire to have the finest or newest or biggest. Both are acceptable reasons for selling.

3. Service Equipment — The life of a machine is generally understood to be the length of time, up to a point, when the repairs equal the original cost. Servicing equipment may be equal in magnitude to sales when parts are taken into consideration. When making machinery purchase decisions, farmers place a high degree of importance on the dealer's service organization.

4. Supply Parts — The local dealer must stock parts for the equipment he or she sells. The wholesaler or parts depot is used as a backup, but the retailer must answer directly to the customer.
5. Arrange Financing — The retailer must finance or arrange financing for his or her own inventory and in addition must assist customers in arranging financing for their needs.
6. Advise Farmers — Retailers must be able to assess the needs of the customers and stock equipment the customers should be buying. The proliferation of technology makes this task an important and complicated one.
7. Providing Manufacturing Feedback — Retailers must assess consumer reaction to and opinion about products purchased, and relay this information to the manufacturer. They must anticipate future trends and assist distributors in determining what will be sold in the future.

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CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agricultural Engineering and Mechanization

PROBLEM AREA: Identifying Career Opportunities in Agricultural Engineering and Mechanization

RELATED PROBLEM AREAS:

1. Identifying Careers in Agriculture/Horticulture (Central Core Cluster)
2. Gaining Employment in an Agricultural Occupation (Central Core Cluster)
3. Identifying Career Opportunities in Agribusiness Management
4. Identifying Career Opportunities in Animal Science
5. Identifying Career Opportunities in Plant and Soil Science
6. Identifying Career Opportunities in Food Science

PREREQUISITE PROBLEM AREA(S)

1. Identifying Careers in Agriculture/Horticulture (Central Core Cluster)

LEVEL: Orientation

OCCUPATIONAL TASKS ADDRESSED: None

STATE GOALS FOR LEARNING

In planning the instruction for this problem area, teachers can promote the development of several student learning objectives which are related to the State Goals for Learning in Biological and Physical Sciences and Social Sciences. These objectives are listed on the Learning Assessment Plan forms included on the following page(s). Those learning objectives marked with an asterisk (*) are taken from the sample lists provided by the Illinois State Board of Education.

Illinois Agricultural Core Curriculum

Agricultural Education 124 Mumford Hall 1301 W. Gregory Drive University of Illinois Urbana, IL 61801

Director: Dale A. Law, Ed.D.
Principal Investigator: Jerry D. Pepple, Ed.D.
Research Assistant: Douglas L. Stockley

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Illinois Agricultural Core Curriculum Rev.

Submission Date ____________________
☐ **Original submission** ☐ **Revision**
Page _____ of _____

I. LEARNING AREA *(check one)*
☐ Language Arts ☐ Fine Arts
☐ Mathematics ☐ Social Sciences
☒ Sciences ☐ Physical Development/Health

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)

COUNTY	DISTRICT	ESC

District Name

City

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will have a working knowledge of the social and environmental implications and limitations of technological development.

Contact Person: ____________________
Title: ____________________
Phone: (   )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Identify careers in which scientific training is important.					
*2. Identify future vocations in science.					

Identifying Career Opportunities in Agricultural Engineering and Mechanization

Agricultural Business and Management
Agricultural Engineering and Mechanization

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ISBE 41-78 (1/88)

Submission Date ____________
☐ Original submission ☐ Revision
Page ____ of ____

ILLINOIS STATE BOARD OF EDUCATION
Department of School Improvement Services
100 North First Street
Springfield, Illinois 62777-0001

LEARNING ASSESSMENT PLAN

Instructions and codes for this form are provided on a separate sheet.

(Affix label or complete district information.)

COUNTY ☐☐☐ DISTRICT ☐☐☐☐ ESC ☐☐

District Name

City

I. LEARNING AREA *(check one)*

☐ Language Arts ☐ Fine Arts
☐ Mathematics ☒ Social Sciences
☐ Sciences ☐ Physical Development/Health

II. STATE GOAL FOR LEARNING

As a result of their schooling, students will be able to apple the skills and knowledge gained in the social sciences to decision making in life situations.

Contact Person: ____________
Title: ____________
Phone: ( )

III. LEARNING OBJECTIVES	IV. ASSESSMENT				V. EXPECTATIONS
By the end of grade *(circle one)* 3 6 8 [✓ 11] students should be able to:	A Types	B Validity/ Reliability	C Commercial Test(s)	D Evidence of Nondiscrimination	Percent of Students Expected to Achieve Objective
*1. Understand the relationship between educational attainment and entry into varied occupational fields.					
*2. Understand the knowledge and skills required for success in selected fields of work.					
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					1798

ISBE 81-78 (1/88)

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agricultural Engineering and Mechanization

PROBLEM AREA: Identifying Career Opportunities in Agricultural Engineering and Mechanization

STUDENT LEARNING OBJECTIVES

Upon completion of their study of this problem area, students will be able to:

1. Identify careers specifically related to Agricultural Engineering and Mechanization.
2. Identify where to obtain information about career opportunities in Agricultural Engineering and Mechanization.
3. Identify the relationships between educational attainment and entry into Agricultural Engineering and Mechanization careers.
4. Identify scientific training, knowledge, and skills required for success in selected Agricultural Engineering and Mechanization career areas.
5. Identify possibilities for future career opportunities in Agricultural Engineering and Mechanization.

INSTRUCTOR'S NOTES AND REFERENCES

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INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agricultural Engineering and Mechanization

PROBLEM AREA: Identifying Career Opportunities in Agricultural Engineering and Mechanization

PROBLEMS AND QUESTIONS FOR STUDY	INSTRUCTOR'S NOTES AND REFERENCES
1. What is Agricultural Engineering and Mechanization?	
2. What are some of the careers in the areas of Agricultural Engineering and Mechanization?	
3. What are some of the sources of information about career opportunities in Agricultural Engineering and Mechanization?	
4. What are the opportunities for employment in Agricultural Engineering and Mechanization?	
5. How does one prepare for a career in Agricultural Engineering and Mechanization?	

INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agricultural Engineering and Mechanization

PROBLEM AREA: Identifying Career Opportunities in Agricultural Engineering and Mechanization

SUGGESTED TEACHING ACTIVITIES AND PROCEDURES

1. Begin the problem area with an interest approach which includes an overview of what is to be studied. See the problem area *Identifying Careers in Agriculture/Horticulture* in the Agricultural Literacy Unit in the Central Core for suggestions.
2. Define Agricultural Engineering and Mechanization professions. (Refer to Information Sheets.)
3. Discuss the question, Why is the area of Agricultural Engineering and Mechanization important?
4. Invite individuals who work in the area of Agricultural Engineering and Mechanization to discuss with the class the value of additional training and experiences in these occupational areas. Have these guest speakers describe their jobs and tasks and discuss the importance of their occupations to society.
5. Have class members do research projects to find literature on careers in Agricultural Engineering and Mechanization. Have each class member contribute information to a classroom "Career Scrapbook" or "Career Bulletin Board."
6. Have students randomly select pieces of paper on which are written titles of jobs in agricultural engineering and mechanization. Then have each student describe to the class the duties of the selected job without mentioning the job title. The rest of the class should attempt to figure out the job title. (Note: Job titles with descriptions may be obtained from the dictionary of occupational titles.)
7. Have students write an Agricultural Engineering and Mechanization job advertisement. The advertisement should be no longer than fifty words and should include the following information: (1) job title, (2) brief job description including working conditions, (3) starting date of job, (4) place where job will be located, and (5) person to contact when applying for job.
8. Have class members prepare a list of businesses in the community that employ Agricultural Engineering and Mechanization professionals.
9. Discuss job opportunities available in Agricultural Engineering and Mechanization with the class.
10. Discuss the education and training necessary for careers in Agricultural Engineering and Mechanization. (You may wish to involve the guidance counselor in this discussion.)
11. Have class members interview employees in the community working in Agricultural Engineering and Mechanization occupations. Have class members write a research report based upon what they learned and observed during the interview. (See Student Worksheet #1.)

INSTRUCTOR'S NOTES AND REFERENCES

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INSTRUCTOR'S GUIDE

CLUSTER: AGRICULTURAL BUSINESS AND MANAGEMENT

UNIT: Agricultural Engineering and Mechanization

PROBLEM AREA: Identifying Career Opportunities in Agricultural Engineering and Mechanization

REFERENCES

1. *Occupational Outlook Handbook.* U.S. Department of Labor, Bureau of Labor Statistics. Washington, DC 20402.

2. *Opportunities in Agriculture Careers.* (1988). Benson, C., White, W.C., Collins, D. VGM Career Horizons, A Division of National Textbook Company, 4255 W. Touhy Avenue, Lincolnwood, IL 60646-1975.

3. *Exploring Career Opportunities in Agriculture* (Subject Matter Unit #1050). Instructional Materials Service, Texas A & M University, P.O. Box 2588, College Station, TX 77843-2588.

4. *Illinois Agricultural Occupations, An Occupational Employment Study of Agricultural Services Industries.* (1989). Pepple, J.D. Illinois State Board of Education, Deptartment of Adult, Vocational, and Technical Education, 100 N. First Street, Springfield, IL 62777.

5. *Work in the New Economy: Careers and Job Seeking in the 21st Century.* Weymann, Chapman, Johnson. AAVIM, Curriculum Publications Clearinghouse, Horrabin Hall 47, Western Illinois University, Macomb, IL 61455. (800) 322-3905 or (309) 298-1917.

6. *Guide for Occupational Exploration.* AAVIM, Curriculum Publications Clearinghouse, Horrabin Hall 47, Western Illinois University, Macomb, IL 61455. (800) 322-3905 or (309) 298-1917.

*7. *Handbook for Agricultural Occupations.* (1985). Hoover, Norman K. 4th edition. Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

8. *Essential Aspects of Career Planning and Development.* (1977). Atherton and Memphrey. Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

9. *Careers in Agribusiness and Industry.* (1980). Stone, A.A., Stone, M.L., Gulvin, H.E. Interstate Publishers, Inc., P.O. Box 50, Danville, IL 61834-0050. (217) 446-0500.

*10. *Employment Opportunities for College Graduates in the Food and Agricultural Sciences.* (1986). Coulter, Stanton, Goecker. Texas A & M University, College of Agriculture, College Station, TX 77843-2142.

*11. *Dictionary of Occupational Titles.* U.S. Department of Labor, Employment and Training Administration. Superintendent of Documents, U.S. Printing Office, Washington, DC 20402

*Indicates highly recommended reference

INSTRUCTOR'S NOTES AND REFERENCES

INSTRUCTIONAL RESOURCES

These resources are intended for use by teachers in planning and teaching the materials for this problem area and may be adapted to fit the teaching method(s) used.

INFORMATION SHEET #1 — Professions in Agricultural Engineering and Mechanization Defined

INFORMATION SHEET #2 — A Comparison of Available Graduates and Employment Opportunities for Food and Agricultural Scientists, Engineers, and Related Specialists

INFORMATION SHEET #3 — A Comparison of Available Graduates and Employment Opportunities for Food and Agriculture Marketers, Merchandisers, and Sales Representatives

INFORMATION SHEET #4 — A Partial Listing of Jobs in Agricultural Engineering and Mechanization

INFORMATION SHEET #5 — Illinois Postsecondary Colleges and Universities Offering Education in Agricultural Engineering and Mechanization Occupations

TRANSPARENCY MASTER #1 — Comparison of Available Graduates and Employment Opportunities Through 1990 in Food and Agricultural Sciences

INFORMATION SHEET #1

Professions in Agricultural Engineering and Mechanization Defined

Agricultural Engineering Professions

These professions combine formal education and training in engineering principles, agricultural science, mathematics, and other basic sciences to solve engineering problems related to agriculture. Jobs in this profession require application of specialized skills and knowledge in designing, developing, and analyzing agriculture machinery and equipment systems and components.

Areas of specialization include:

1. Electrical Power and Processing.
2. Food Engineering.
3. Power and Machinery.
4. Soil and Water.
5. Structures and Environment.

Agricultural Mechanics Professions

These professions combine formal education and training in specialized mechanical areas/systems, agricultural science, mathematics, and other basic sciences to solve mechanical problems related to agriculture. Jobs in this profession require application of specialized skills and knowledge in testing, marketing, utilizing, servicing, and managing agricultural machinery and equipment systems and components.

Areas of specialization include:

1. Power and Machinery.
2. Rural Electrification.
3. Buildings and Conveniences.
4. Soil and Water Management.
5. Processing and Handling.

INFORMATION SHEET #2

A Comparison of Available Graduates and Employment Opportunities for Food and Agricultural Scientists, Engineers, and Related Specialists

Scientists Engineers, and Related Scientists

U.S. employment data indicate expanding career opportunities in science, engineering, and related professions for agriculture, natural resources, and veterinary medicine for college graduates. These public and private sector professionals will play a critical role in carrying out essential research and development initiatives to enhance the competitive position of U.S. technology in the world market.

In the aggregate, almost 14,000 openings are projected in the United States through 1990. Slightly more than 11,600 qualified college graduates are anticipated per annum, leaving a projected annual deficit of more than 2,000 graduates for research, engineering, and technical positions.

The strongest employment opportunities will be for persons having doctoral degrees or postdoctoral experience in molecular genetics, biochemistry, food science, food engineering, nutrition, environmental science, and soil science. Also, it is expected that approximately 2,000 new veterinarians will be employed during each of the next five years.

More than 800 scientific and engineering openings are projected annually for foresters and natural resource conservationalists, an increasing proportion of which are likely to be in the private sector. New employment opportunities for landscape architects are expected to exceed 500 each year.

During the late 1970s and early 1980s, fewer individuals enrolled in agricultural and life science programs at U.S. colleges and universities. This enrollment decline occurred during the advent of significant expansion of biotechnology research related to our nation's food system. Also, increasing research activity is emerging with regard to postharvest use of agricultural commodities and timber.

Throughout the remainder of the 1980s, more than one-fourth of new college graduates who will qualify for positions as food and agricultural scientists, engineers, and related specialists will earn degrees in allied fields closely related to natural resources, agriculture, and veterinary medicine. The principal complementary disciplines are expected to be chemical engineering, civil engineering, and industrial engineering, along with selected biological science specialties such as microbiology, molecular genetics, biochemistry, physiology, and cell biology.

Slightly more than 6,000 of the 14,000 openings for scientists, engineers, and related specialists are of such a nature that master's or doctoral degrees will likely be required for entry level positions. On the other hand, only 4,500 qualified advanced degree recipients are projected to be available annually. Consequently, two-thirds of the total projected shortfall of food and agricultural scientists, engineers, and related specialists are in occupations likely to require graduates with advanced degrees.

Examples:

Agricultural Engineer
Animal Scientist
Biochemist
Biometrician
Entomologist
Environmental Engineer
Food Engineer
Food Scientist
Forest Engineer
Forest Scientist
Geneticist
Landscape Architect

Microbiologist
Nutritionist
Physiologist
Plant Scientist
Rangeland Scientist
Safety Engineer
Soil Scientist
Technician
Toxicologist
Veterinarian
Water Engineer
Weed Scientist

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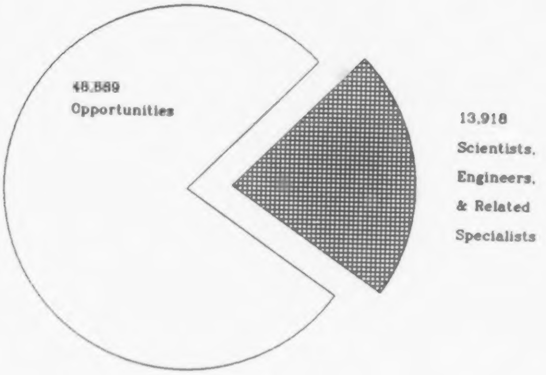
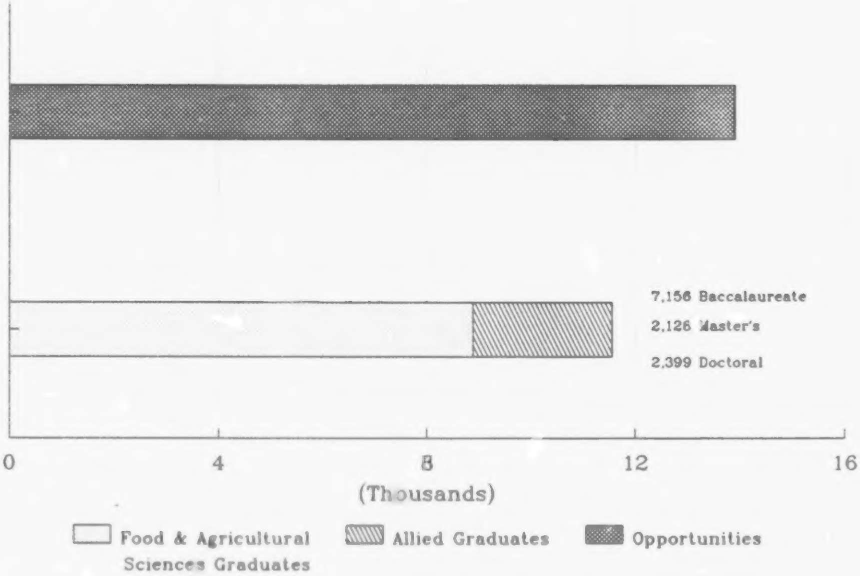




Employment Opportunities for College Graduates in the Food and Agricultural Sciences by K. June Coulter, Morse Stanton, and Allen Goecker. Texas A & M University, College Station, TX 77843-2142, (409) 845-3711. Source of this data is a report conducted every five years. The next opportunity to acquire new information is 1991.

INFORMATION SHEET #3

A Comparison of Available Graduates and Employment Opportunities for Food and Agriculture Marketers, Merchandisers, and Sales Representatives

In 1984, U.S. consumers spent $332 billion for food produced by farmers. Of this total, some $242 billion were expended for processing, marketing, and other functions in the farmer-to-consumer food system. Also, farm supply and service industries added an estimated $178 billion to the U.S. gross national product and employed some 4.2 million people.

Economic activity of this magnitude requires a continuing extensive infusion of college educated professionals. Projections indicate that through 1990, there will be more than 15,000 annual openings in sales, merchandising, and marketing for new graduates having food and agricultural expertise. Professional positions requiring such expertise include technical sales representatives, buyers, brokers, market analysts, and customer service representatives.

Some 11,725 baccalaureate degree recipients will account for more than 85% of the new graduates who will be qualified each year for entry positions in food and agricultural marketing, merchandising, and sales. It is expected that slightly more than half of the qualified graduates will have specializations in agriculture, natural resources, or veterinary medicine. The remainder will complete degree specializations in closely allied programs such as business, economics, product management, and purchasing.

Fewer than 1,450 master's and doctoral degree recipients are estimated to be available to assume professional positions in food and agricultural marketing, merchandising, and sales each year through 1990. Principal employment opportunities for these individuals will be in purchasing and buying, market analysis, and technical sales, as well as international trade.

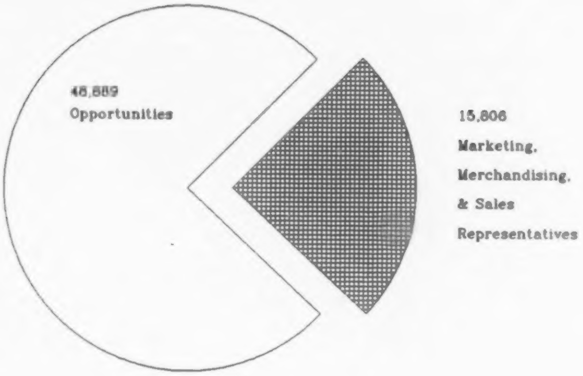
It is important to note that about one-third of all food and agricultural employment opportunities for college graduates throughout the remainder of the decade will be in marketing, merchandising, and sales. The best qualified individuals will have strong academic credentials that reflect business and communication skills in addition to a technical understanding of food and fiber production and/or processing. Graduates also having specific preparation in sales techniques will likely receive the greatest attention from prospective employers.

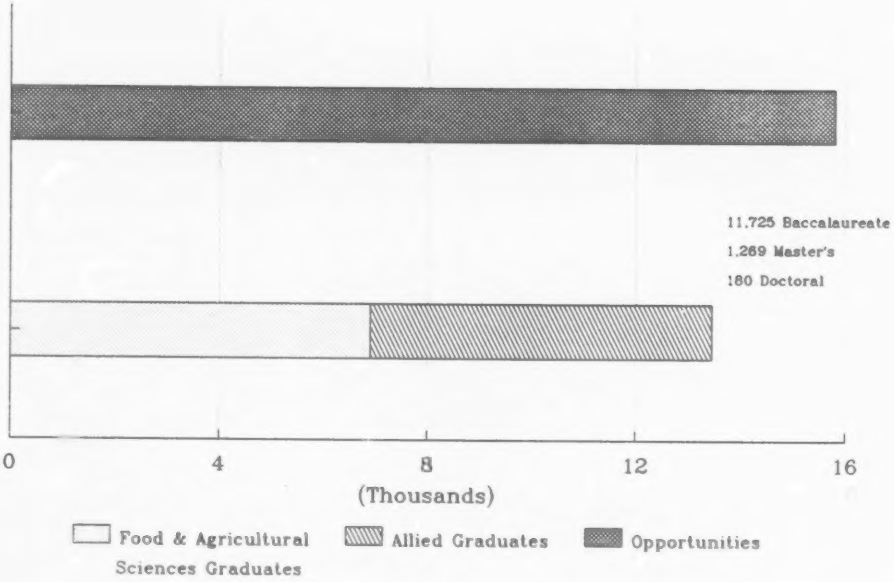
Increased numbers of qualified baccalaureate and master's degree recipients will be needed to fill available positions in this employment area. During the next five years, the quantity of marketing, merchandising, and sales positions associated with postharvest food and fiber distribution will continue to expand. In contrast, a reduction in the number of similar positions in farm supply and service industries is anticipated.

At the doctoral level, a shortfall of food and agricultural graduates with expertise in international food marketing and trade exists. This condition is likely to worsen as U.S. companies continue to become multinational in scope.

Examples:

Commodity Broker
Food Broker
Grain Merchandiser
Insurance Agent
Livestock Buyer
Market Analyst
Marketing Manager
Sales Representative
Technical Service Representative
Timber Buyer





Employment Opportunities for College Graduates in the Food and Agricultural Sciences by K. June Coulter, Morse Stanton, and Allen Goecker. Texas A & M University, College Station, TX 77843-2142, (409) 845-3711. Source of this data is a report conducted every five years. The next opportunity to acquire new information is 1991.

INFORMATION SHEET #4

A Partial Listing of Jobs in Agricultural Engineering and Mechanization

D.O.T Number	Job Title
013.061-010	Agricultural Engineer
013.061-018	Design-Engineer, Agricultural Equipment
013.061-022	Test-Engineer, Agricultural Equipment
184.167-050	Maintenance Supervisor
272.357-014	Sales Representative, Farm and Garden Equipment
272.357-018	Sales Representative, Poultry Equipment
401.161-010	Farmer, Cash Grain
408.662-010	Hydro-Sprayer Operator
409.685-010	Farm-Machine Tender
409.685-014	Irrigator, Sprinkling System
421.161-010	Farmer, General
529.382-018	Dairy-Processing, Equipment Operator
624.281-010	Farm-Equipment Mechanic
624.361-010	Inspector and Tester, Agricultural Equipment
624.361-014	Sprinkler-Irrigation, Equipment Mechanic
624.381-018	Farm-Machinery Set-Up Mechanic
625.261-010	Diesel-Engine Tester
625.281-010	Diesel Mechanic
625.281-018	Engine Repairer, Service
625.281-022	Fuel-Injection Servicer
625.281-034	Small-Engine Mechanic
810.384-014	Welder, Arc
824.261-010	Electrician
869.567-010	Surveyor Helper
869.664-014	Construction Worker

INFORMATION SHEET #5

Illinois Postsecondary Colleges and Universities Offering Education in Agricultural Engineering and Mechanization Occupations

Blackhawk College
East Campus, P.O. Box 489
Kewanee, IL 61443

Carl Sandburg College
P.O. Box 1407, 2232 S. Lake Storey Road
Galesburg, IL 61401

Danville Area Community College
2000 East Main Street
Danville, IL 61832

Illinois Central College
East Peoria, IL 61635
(309) 694-5414

Illinois Eastern Community Colleges
Wabash Valley College
2200 College Drive
Mt. Carmel, IL 62863
(618) 262-8641

Illinois Valley Community College
RR #1
Oglesby, IL 61348
(815) 224-2720

Kankakee Community College
Box 888
Kankakee, IL 60901
(815) 833-0309

Kishwaukee College
Box 29
Malta, IL 60150
(815) 825-2086

Lake Land College
South Route 45
Mattoon, IL 61938
(217) 235-3131

Lincoln Land Community College
Shepherd Road
Springfield, IL 62708
(217) 786-2416

Parkland College
2400 W. Bradley
Champaign, IL 61821
(217) 351-2213

Rend Lake College
Ina, IL 62846
(618) 437-5321

Spoon River College
RR #1
Canton, IL 61520
(309) 647-4645

Illinois State University
Department of Agriculture
Normal, IL 61761
(309) 438-8550

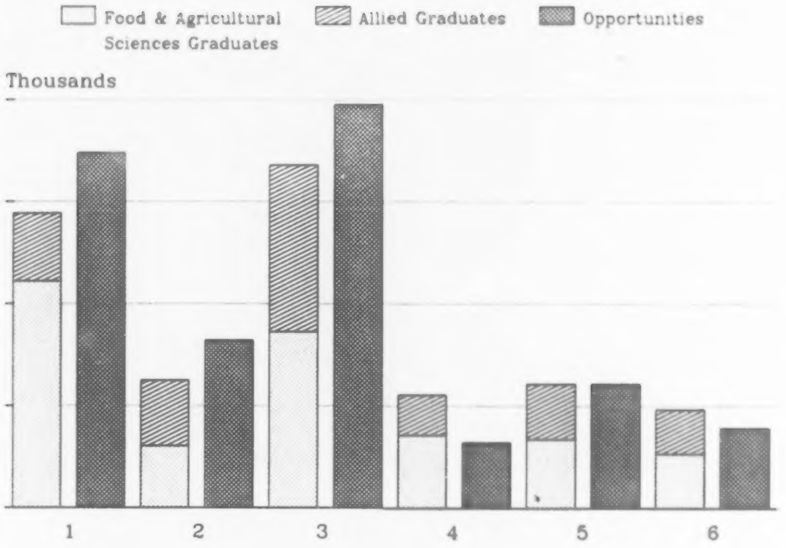
Southern Illinois University
Agriculture Education and Mechanization
SIU/C, Carbondale, IL 62901
(618) 536-7733

University of Illinois
Agricultural Engineering Department
Agricultural Engineering Sciences Building
1304 West Pennsylvania Avenue
Urbana, IL 61801
(217) 333-3570

Western Illinois University
Department of Agriculture
Macomb, IL 61455
(309) 298-1080

TRANSPARENCY MASTER #1

Comparison of Available Graduates and Employment Opportunities Through 1990 in Food and Agricultural Sciences



1 Scientists, Engineers, & Related Specialists
2 Managers & Financial Specialists
3 Marketing, Merchandising, & Sales Representatives
4 Education, Comm., & Inform. Specialists
5 Social Services Professionals
6 Agricultural Production Specialists

Employment Opportunities for College Graduates in the Food and Agricultural Sciences by K. June Coulter, Morse Stanton, and Allen Goecker. Texas A & M University, College Station, TX 77843-2142, (409) 845-3711. Source of this data is a report conducted every five years. The next opportunity to acquire new information is 1991.

STUDENT ACTIVITIES

STUDENT WORKSHEET #1 — Career Research Report

For additional activities, teachers may refer to the "Suggested Teaching Activities and Procedures" section in the Instructor's Guide.

STUDENT WORKSHEET #1

Career Research Report

Date ____________________ **Student Name** ______________________________________

Name of Person Interviewed: ______________________________________

Company (Name): ______________________________________

Address: ______________________________________

____

Phone: (   ) ____________________

1. Occupational Area: ______________________________________
2. Occupational Title: ______________________________________
3. Major Duties: ____________________ ____________________

____________________ ____________________

____________________ ____________________

____________________ ____________________

____________________ ____________________

4. What education and training is required to become employed at the entry level in this job?

5. What do you like most about this job?

6. What are the least desirable aspects of this job?

7. What type of salary and benefits can an entry level employee expect to receive in this type of job?

8. Are there current and projected opportunities for employement in a job such as this one? (Please explain.)

9. Will this job likely allow for some advancement? (Please explain.)

10. What advice would you give someone who is considering a career in this occupational area?

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